TERRA

MAGAZINE OF THE
NATURAL HISTORY MUSEUM
OF LOS ANGELES COUNTY

VOLUME 29, NO. 4
SUMMER 1991

"DINOSAURS, LIVING AND BREATHING"

SCIENTIFIC AMERICAN

The Natural History Museum of Los Angeles County has published a classic work on dinosaurs in its two-volume book, Dinosaurs Past and Present.

"These volumes are first-class, from their dazzling covers, nice heft, and sound workmanship, to the high quality of their technical content and exposition."
Earth Science History

"Fresh images, striking graphs, entire parades of tracks and plenty of informed argument."
Scientific American

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Bookwatch, Midwest Book Review

"The drama of the action and colour in some of these paintings literally takes the breath away."
Mike Benton, *New Scientist*

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Booklist, American Library Assn.

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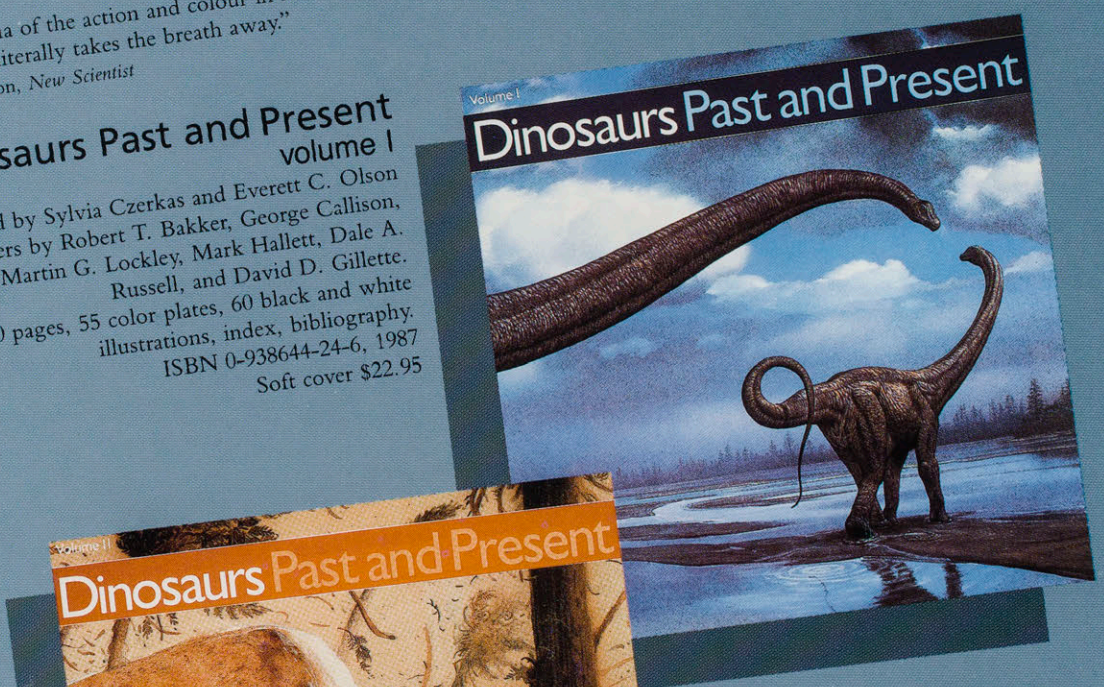
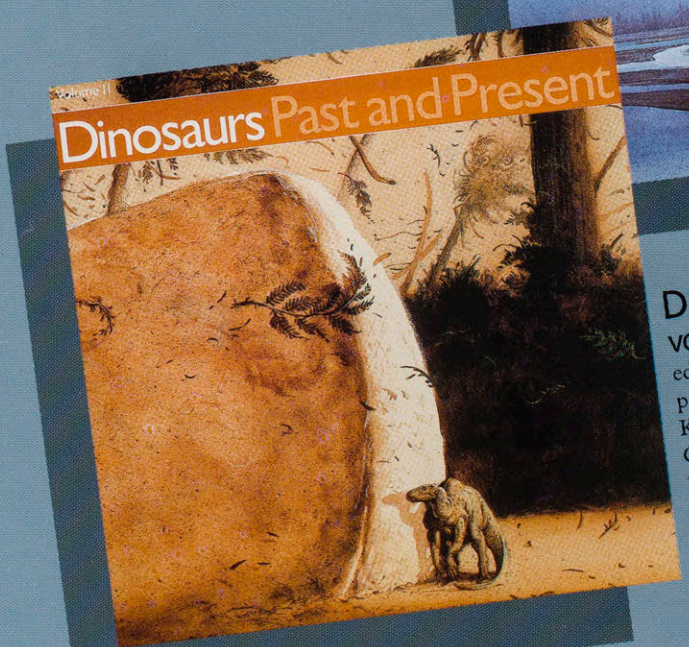
Frank L. DeCourten, *Explorer*

"Wonderful books. Highly recommended."
Donald J. Heintzelman, *Wildlife Book Review*

Dinosaurs Past and Present
volume I

edited by Sylvia Czerkas and Everett C. Olson
papers by Robert T. Bakker, George Callison, Martin G. Lockley, Mark Hallett, Dale A. Russell, and David D. Gillette.
180 pages, 55 color plates, 60 black and white illustrations, index, bibliography.
ISBN 0-938644-24-6, 1987
Soft cover $22.95





Dinosaurs Past and Present
volume II

edited by Sylvia Czerkas and Everett C. Olson
papers by Gregory S. Paul, John R. Horner, Kevin Padian, Stephen A. Czerkas, Philip J. Currie, and J. Keith Rigby, Jr.
164 pages, 33 color plates, 100 black and white illustrations, index, bibliography.
ISBN 0-038644-23-8,1987
Soft cover $22.95

To order your copies and receive your Museum Member's discount on the purchase price, contact

The Museum Bookstore
900 Exposition Blvd., Los Angeles, CA 90007
Telephone 213/744-3434

Dinosaurs Past and Present is the catalog to the exhibit on view at the Natural History Museum of Los Angeles County from 8 June through 25 August 1991.

COVER:
Pisanosaurus, 1989
by Douglas
Henderson
22½ X 16½ inches
Pastel on Paper

TERRA

THE NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY

VOLUME 29 NO. 4

SUMMER 1991

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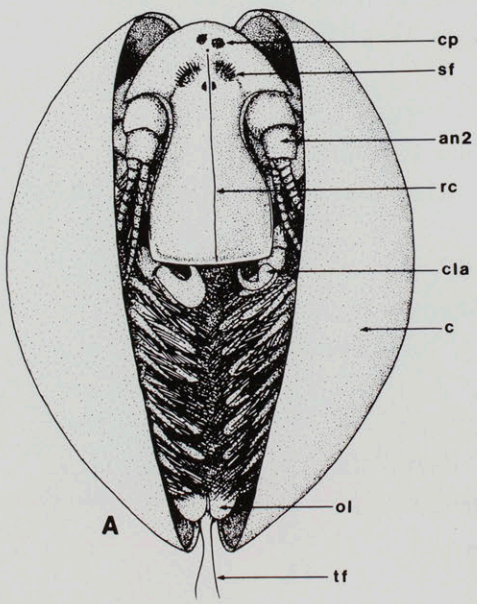
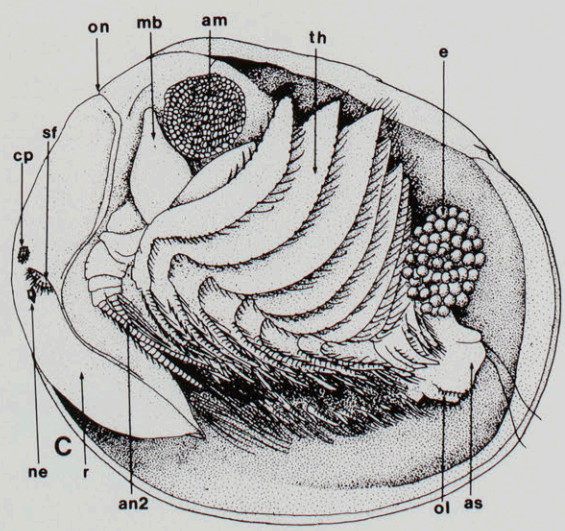




A conchostracan or "clam shrimp" belonging to the genus *Lynceus*. This organism and other members of a primitive group of crustaceans will be subjects of Dr. Joel W. Martin's research in the museum's new molecular and biochemical systematics laboratory. These illustrations by Dr. Martin are from *Zoologica Scripta*, the journal of the Norwegian Academy of Science and Letters.

GRANTS

■ **AMERICAN PHILOSOPHICAL SOCIETY FUNDS RNA RESEARCH** Dr. Joel W. Martin received a grant of $2,000 from the American Philosophical Society for his research proposal "Phylogeny of hydrothermal vent crabs based on ribosomal RNA." The origin of the crabs living at deepsea hydrothermal vents is unknown. Dr. Martin will be extracting and sequencing the ribosomal RNA nucleotides from these crabs in an effort to understand their evolution and relationship to other families of crabs.

■ **NATIONAL SCIENCE FOUNDATION GRANT TO EQUIP NEW SYSTEMATICS LABORATORY** Dr. Sarah B. George, Associate Curator in the Mammalogy Section, and Dr. Joel W. Martin, Associate Curator in the Invertebrate Zoology Section, have received a grant from the National Science Foundation for $104,000 to provide some of the fixed equipment and cabinetry for the planned laboratory of molecular and biochemical systematics. The new laboratory, which was briefly described in the last issue of TERRA (volume 29, numbers 2-3, page 5) will facilitate studies on evolutionary relationships in a variety of plant and animal groups.

■ **NATIONAL SCIENCE FOUNDATION GRANT SUPPORTS ECHINODERM COLLECTION** In September 1990, the National Science Foundation's Biological Resources Research Program provided $209,950 for the improvement of the Natural History Museum's echinoderm collection. During the last decade, the collection has grown rapidly, chiefly through the incorporation of the Allan Hancock Foundation holdings and other "orphaned" collections. The Natural History Museum now houses the largest echinoderm collection in the western United States and the third largest in the country; it is cosmopolitan, with outstanding coverage of the eastern Pacific and Caribbean faunas. The upgrade will make these collections more accessible than they have been previously; the collections are now available to the scientific community for study, and loans of specimens are being expedited. Some NSF funds are available to support visits to the museum by specialists who will assist in identifying portions of the collection.

As principal investigator, Dr. Gordon Hendler, Curator and Section Head of Invertebrate

Zoology at the Natural History Museum, has implemented an 18-month program designed to reorganize and transfer the specimens to two environmentally controlled areas within the museum. He is being assisted by Sherman Suter (NSF-funded collections manager) and by Cathy Groves (museum curatorial assistant). New compactor carriages are being installed to hold alcoholic collections, and new steel museum cabinets have been purchased to store dried specimens. Wet material will be transferred from inadequate glassware to new bottles, re-alcoholed, and moved to compactors; dry specimens will be transferred from substandard containers to polystyrene boxes. In addition, a collection inventory will be prepared to serve as the basis for further upgrading of storage equipment and for processing and cataloging the existing holdings.

■ **RESEARCH GRANTS FOR BRITTLESTAR STUDIES** Dr. Gordon Hendler (Curator and Section Head of Invertebrate Zoology) and Dr. Donald Manahan (Professor of Biology, University of Southern California) have studied the capacity of sponge-dwelling organisms to take up dissolved nutrients through their skin. In a sense, their research deals with animals that "sponge off of sponges." Hendler and Manahan did their field work on the Belize Barrier Reef in Central America, supported by research grants provided by the Smithsonian Institution's Caribbean Coral Reef Ecosystems Program and the Taylor Science Fund of the Natural History Museum.

The subject of their project, *Ophiactis savignyi*, is probably the most abundant brittlestar in the world and a common component of tropical marine habitats. The species seems to grow larger when it lives in sponges than when it lives in seaweed. Individuals in sponges are sexually and asexually reproductive, but those in seaweed only reproduce asexually, by breaking apart and regenerating.

Hendler and Manahan set out to find whether the differences in size and reproduction are related to the level of dissolved nutrients in sponges. The two scientists designed experiments to determine the ability of brittlestars to utilize dissolved chemicals. Their research will shed light on many intriguing symbioses between marine sponges and associated organisms, and on the ability of marine animals to use dissolved organic substances — a resource 10 times more abundant than the particulate organic material in seawater.

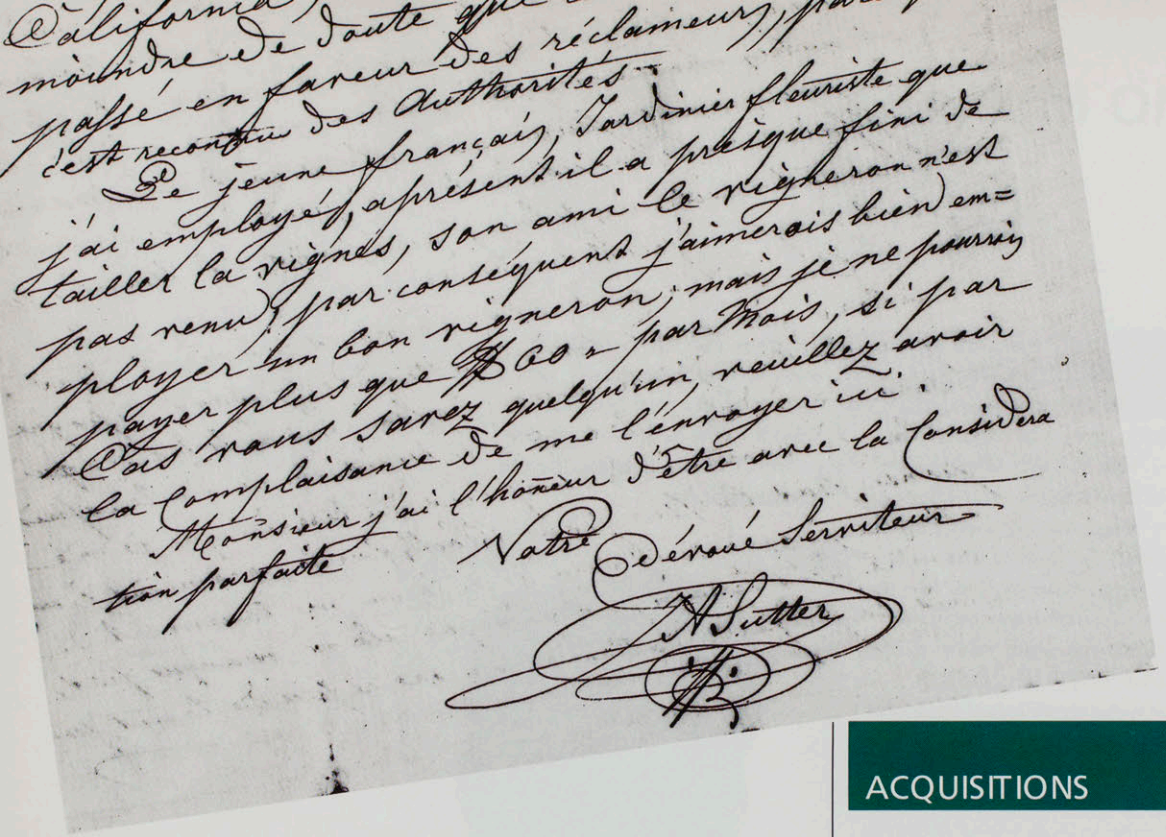
STAFF

■ **FIRST CONSERVATOR JOINS THE STAFF** Sharon Blank became the Natural History Museum's first conservator in August of 1990. She is in the History Division, and has been given the responsibility of developing a conservation program for the entire museum. She is a specialist in object conservation with an emphasis in organic materials, particularly plastic and rubber. She is internationally known for her lectures on the deterioration of plastic objects ranging from space suits to Barbie dolls. She has extensive experience in exhibits conservation and storage and has treated a wide variety of objects, from Neanderthal tools to contemporary art.

Before joining the museum, Ms. Blank worked at the Los Angeles County Museum of Art, the National Museum of American History, the Peabody Museum, and with the National Parks Service. She has a master's degree in Art Conservation from the University of Delaware/Winterthur Program. Her undergraduate work was in biochemistry, and she worked at Harvard Medical School in the neurobiology department before heeding the call to conservation.

Sharon Blank, the Natural History Museum's Conservator

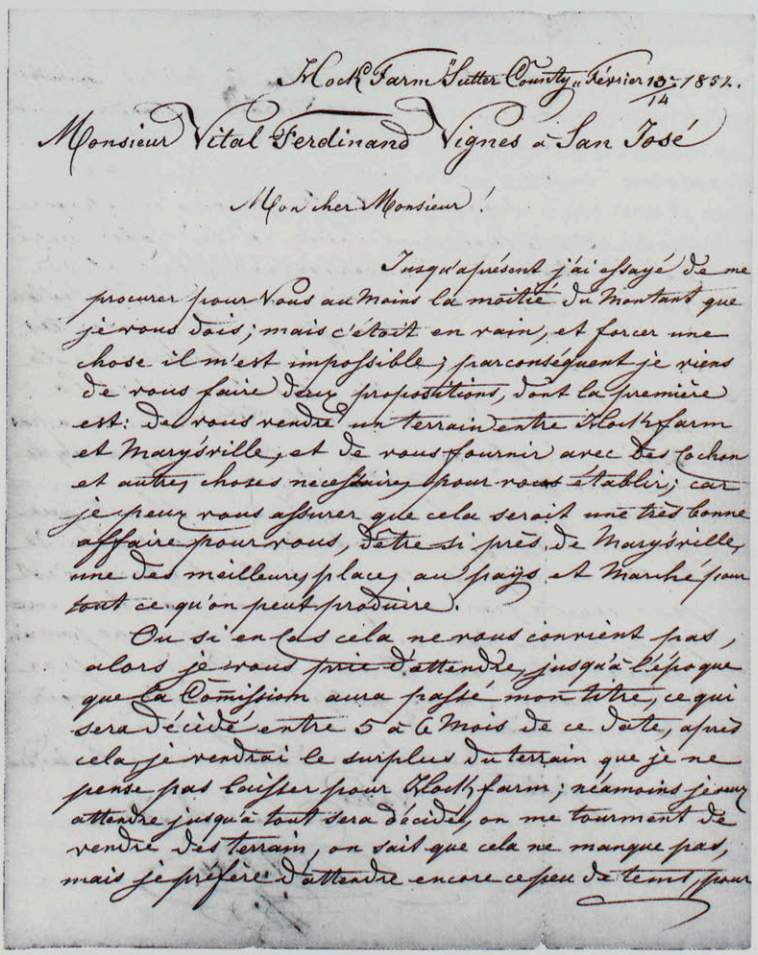
■ **SHARKS! NAMED EXHIBIT OF THE YEAR** The traveling exhibit, SHARKS! Fact and Fantasy, organized by the Natural History Museum of Los Angeles County was among four exhibitions to receive the 1991 Exhibit of the Year Award from the Curators' Committee of the American Association of Museums. The exhibit presents facts about the biology and behavior of sharks to show how wonderfully unique and diverse these animals are and to dispel some common misconceptions about them. The exhibit, which was conceived and curated by Judith L. Chovan, Camm C. Swift, and Jeffery Seigel, was on display here at the Natural History Museum during the summer of 1990 and is currently on a 5-year tour of fourteen museums in the US and Canada.



ACQUISITIONS

SEAVER CENTER ACQUIRES VIGNES PAPERS

Errol Stevens, Curator and Section Head of the Seaver Center for Western History Research, has announced that the section has received an important donation of the papers of Vital Ferdinand Vignes, one of the pioneer French settlers of Los Angeles County. Diane Haggerty, great granddaughter of Vital Vignes, presented the gift to the museum. The Vigneses were prominent members of a small but influential French community in 19th-century Los Angeles. The family patriarch was Vital's uncle, Jean Louis Vignes, who came to California in 1831 from his home canton of Cadillac, France. He planted what was probably the first orange grove in the city of Los Angeles and was a founder of the southern California wine industry. The elder Vignes's property was called El Aliso, for the huge sycamore that shaded it (a misnomer; aliso means alder). Two present-day Los Angeles thoroughfares, Vignes and Aliso streets, remind us of this pioneering family.



Mock Farm Sutter County, Février 13/14 1852.

Monsieur Vital Ferdinand Vignes à San José

Mon cher Monsieur!

Jusqu'à présent j'ai essayé de me procurer pour Vous au moins la moitié du Montant que je vous dois; mais c'était en vain, et forcer une chose il m'est impossible; par conséquent je viens de vous faire deux propositions, dont la première est: de vous vendre un terrain entre Mock Farm et Marysville, et de vous fournir avec des cochon et autres choses necessaires pour vous établir; car je peux vous assurer que cela serait une très bonne affaire pour vous, d'être si près de Marysville une des meilleures places au pays et Marché pour tout ce qu'on peut produire.

Ou si en cela cela ne vous convient pas, alors je vous prie d'attendre jusqu'à l'époque que la Comission aura passé mon titre, ce qui sera décidé entre 5 à 6 Mois de ce Date, après cela je vendrai le surplus du terrain que je ne pense pas toucher pour Mock Farm; néanmoins je veux attendre jusqu'à tout sera décidé, on me tourment de vendre des terrain, on sait que cela ne manque pas, mais je préfère d'attendre encore ce peu de tems pour

MEMBERSHIP

■ **OPEN HOUSE** On the evening of February 1, museum members explored all five floors of the Natural History Museum at the 1991 Open House. Members visited new and renovated exhibits in the public areas of the building, including the Ralph W. Schreiber Hall of Birds, the gold exhibit in the Gem and Mineral Hall, the Ralph M. Parsons Insect Zoo Preview, and the dinosaur fossils in the Mesozoic Fossil Hall. Offices, laboratories, and storerooms were also open, and museum staff organized entertaining exhibits especially for the annual event. The General Americana section of the History Division used its doll collection to demonstrate how an object becomes part of its permanent collection. Drawers, shelves, and jars of exotic and fascinating specimens in the Life Sciences sections attracted many interested visitors. Members gathered to learn about the activities in the Earth Sciences Division, including Vertebrate Paleontology's casting of the *Tyrannosaurus rex* skull. In the Education Division's programs in the Discovery Center, children listened wide-eyed to a storyteller and created Eskimo hats to wear home. The Foyer bustled with activity as museum members purchased items at a Special Open House Sale organized by the museum stores, met artist William Stout of the Dinosaurs, Penguins, and Whales exhibition, viewed the special presentation of a video on the Megamouth shark, and smiled for a photo with a Triceratops.

Refreshments for the event were provided by FIBAR, Garden of Eatin', Hansen Beverage Company, Lawry's Foods, Inc., Mother's Cake and Cookie Company, Sparkletts Drinking Water Corporation, Sunkist Growers, Inc., and Trader Joe's.

ACKNOWLEDGMENTS

The TERRA editors thank the magazine's Editorial Board members and the following people for special assistance in preparing this issue.

Remember the Children Stephen Goodell, Alvin Rosenfeld, Sybil Milton, and Derek Symer, U.S. Memorial Holocaust Council.

Musings on the Origin of Birds Dr. Kenneth C. Parkes, Carnegie Museum of Natural History, Pittsburg; Dr. John H. Ostrom, Yale University, New Haven.

Visitors enjoy the 1991 Open House.

CHRISTOPHER BARR PHOTOGRAPHY

Dinosaurs — A Global View

A new exhibition, organized by Sylvia Czerkas and Stephen Czerkas, examines the worldwide events leading to the evolution and extinction of the dinosaurs.

"Baby *Titanosaurus*," a model by Stephen Czerkas.

IMAGINE, SAY THE CZERKASES, A WORLD where humans did not exist, a lush and vibrant world where many of the animals were of titanic size. This was the world of gigantic reptiles, the dinosaurs.

How did these great reptiles come into existence? Why did they dominate the earth for so many millions of years? What ultimately caused their demise? The answers to these and many other questions about dinosaurs can begin to be resolved by studying their fossil remains, the world in which they lived, their primitive ancestors, and other forms of life that existed long before the first dinosaurs appeared. Dinosaurs — A Global View helps us to understand this complex and fascinating story by providing pictorial representation of many of the "diverse cast of characters" involved.

The dominant role of the dinosaurs during the Mesozoic Era lasted 140 million years, from late in the Triassic Period 205 million years ago through the Jurassic Period to the end of the Cretaceous Period, 65 million years ago. Such a time span may be difficult to comprehend, yet it is only a fraction of the history of life on Earth, where the very earliest forms of life, primitive single cells, came into existence at least 3.5 billion years ago. Life on Earth has changed tremendously since the time when it was dominated by these single cells, partly because Earth itself has undergone dramatic changes. To better visualize these changes, imagine looking at Earth from the moon, and using a time-lapse camera to record its history over the past 4.6 billion years. You would see the first oceans form from the gaseous clouds of a volcanic world, gradually inundating the barren planet until two thirds of its surface was covered by water. Only the most elevated portions of the rocky crust would remain isolated above the oceans to form the continents. These empty continents would not be motionless, but would migrate slowly across the surface of Earth, developing a reddish hue as the atmosphere containing life-supporting oxygen developed above the surface of the planet. The continents would collide, causing huge mountain ranges to rise. These would then be whittled away by erosion through atmospheric processes. Seas would inundate the land, then drain away; glaciers and polar caps would spread their white covering, only to melt back again into the flooding seas; and a new color, green, would at first outline and then cover the continents.

At about 200 million years ago, you would observe the continents merging with each other, forming the supercontinent we call Pangaea, and coincidentally heralding the Age of Dinosaurs. This supercontinent, now vibrantly colored in blues and greens, would eventually fragment, the continents

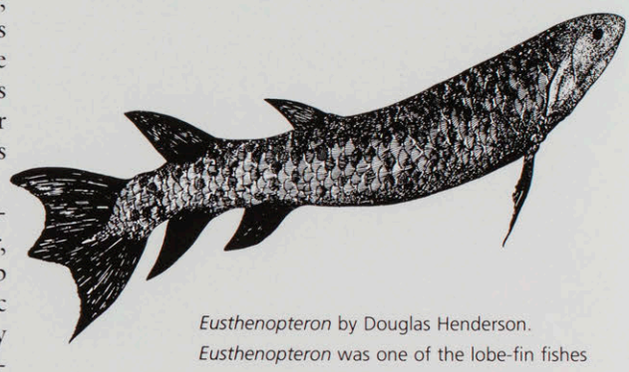
OPPOSITE ▶
"*Struthiomimus* With Fire" by Douglas Henderson.

pulling apart from each other, until they finally assumed their distribution of today.

Three and a half billion years ago, during the Proterozoic Era, algae and other simple, aquatic plant-like organisms first began to exploit the previously barren oceans while the continents remained a lifeless void of erosional activity. Then, in the late Silurian Period (420 million years ago), primitive plants that had long been restricted to an aquatic environment began to develop vascular tissues, which circulated life fluids and strengthened stems and rooting systems. These plants now had the means to exploit the land. By taking advantage of this opportunity they changed the entire surface of our planet, facilitating an explosive radiation of animals within the new terrestrial habitats they provided.

All terrestrial vertebrates (animals with backbones that live on land) share a common ancestor, derived from a group of fishes, which was to develop lungs to enable it to breathe outside of its aquatic habitat and limbs to assist in propelling its body across the surface of the land. *Eusthenopteron*, a lobe-finned fish, exemplifies the kind of vertebrate from which terrestrial forms were derived. Modifications of the swim bladder of such fish to form lungs, and of their pectoral and pelvic fins to produce weight-bearing limbs, resulted in the evolution of early amphibians like *Ichthyostega* during the late Devonian Period about 374 million years ago.

The descendants of animals like *Ichthyostega* dominated what we now call the Age of Amphibians. For millions of years the amphibians were prolific, with diverse, often bizarre variations in shape and



Eusthenopteron by Douglas Henderson. *Eusthenopteron* was one of the lobe-fin fishes that were ancestors of the first amphibians.

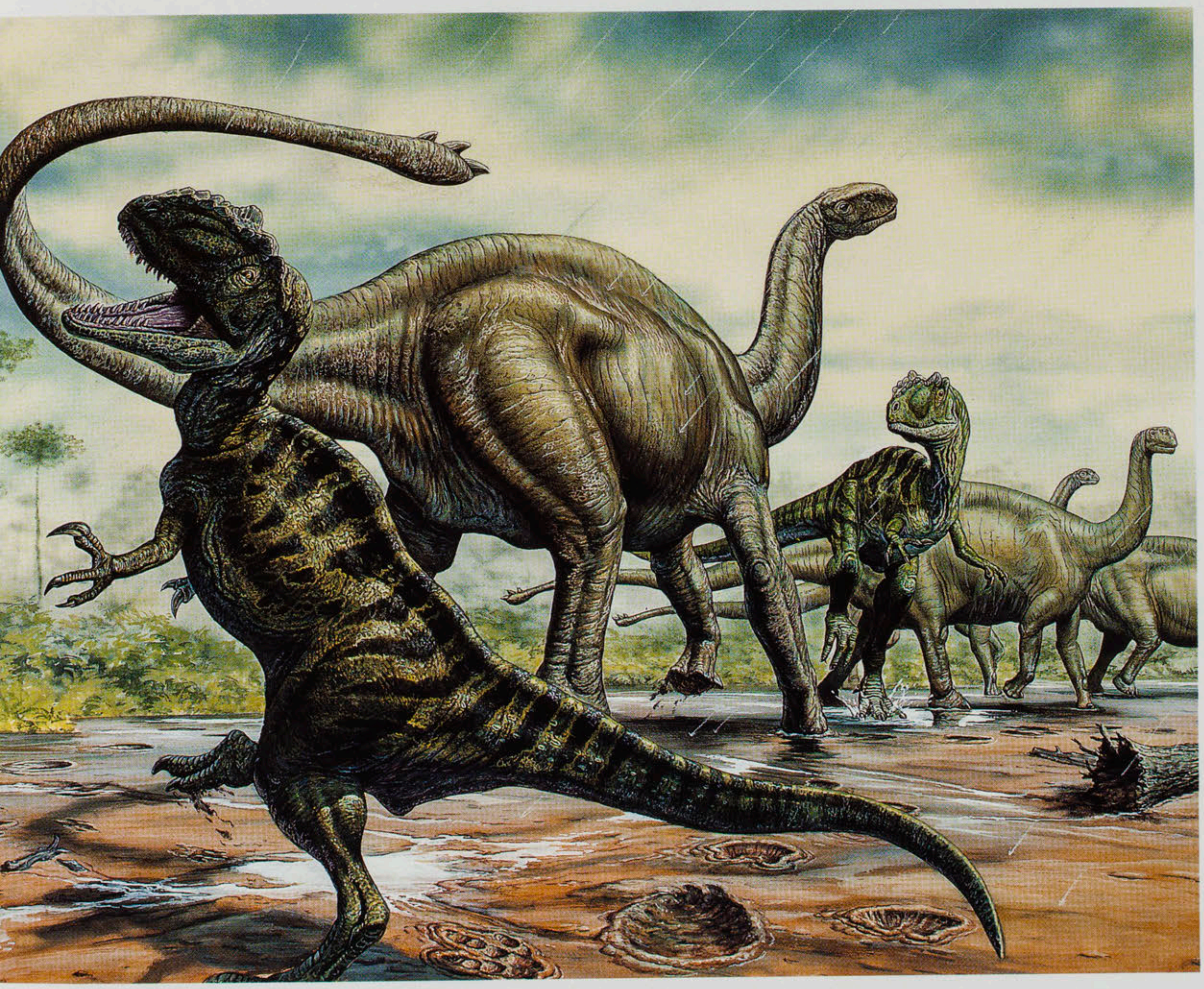
"*Quetzalcoatlus* and Rocky Mountain Uplift" by Douglas Henderson.

Ichthyostega by Douglas Henderson.
Ichthyostega, an early amphibian,
retained many fish-like characteristics.

size, from the tiny to the huge. Although these amphibians may have spent much of their life on land, they always remained close to their ancestral, aquatic habitats, to which they were still tied by their method of reproduction. The laying of the egg would remain restricted to water until such time that a protective shell was evolved.

It is believed that some time during the Lower Carboniferous period, about 338 million years ago, the first amniotic eggs were laid on land, thereby breaking the bond to aquatic reproduction. This enabled the earliest primitive reptiles to exploit the hitherto untapped resources beyond the water's edge.

"*Dilophosaurus* and *Scutellosaurus*"
by Mark Hallett.



Shunosaurus and theropods by Mark Hallett.

NEXT PAGE ▶

"*Triceratops* Battle" by Mark Hallett.

Cacops, *Casea brolli*, and *Varanops*
by John Sibbick.

For much of the next 150 million years, reptiles competed for the available terrestrial resources. Changing environmental conditions and rivalry within and between reptilian groups spurred new evolutionary development that intensified diversity in size and behavioral adaptations. Dinosaurs ruled the land but other reptiles exploited the oceans and skies. The reptiles, it would seem, were on a course of world dominance that would last throughout the Mesozoic Era. It was a reign that suffered few challenges by more highly evolved vertebrates such as birds and mammals who inherited the planet when, for reasons still not yet fully explained, the dinosaurs became extinct.

Dinosaurs — A Global View is a new exhibition of dinosaur restorations — paintings, drawings, graphics, and sculptures — organized by Sylvia and Stephen Czerkas. Based on the evidence of fossil bones, bone beds, tracks, and plant remains, it traces the evolution of the earliest reptiles through the Carboniferous and Permian periods to their rise to dominance in the Jurassic.

The exhibition contains 74 original paintings and drawings by Mark Hallett, Douglas Henderson, and John Sibbick, as well as the Czerkases' incomparable models, including a 20-foot-long *Styracosaurus* and a 10-foot-long *Deinonychus*. An illustrated 247-page volume, *Dinosaurs — A Global View* that elaborates on the themes of the exhibition has been written by the Czerkases. Like the exhibit, the book examines the evolution of the dinosaurs in terms of their biogeographical context, taking into account the effects of plate tectonics on climate and emerging ecosystems. The exhibition opens at the Natural History Museum on June 8, 1991. After leaving the museum on August 25, it will appear at other museums in the United States, Canada, and Europe.

John M. Harris
Chief Curator, Earth Sciences

Deinonychus model by Stephen Czerkas.

OPPOSITE ▶
Hylonomus by Douglas Henderson.

Musings on the Origin of Birds

Facts and Dogma in Conflict

by Kenneth E. Campbell, Jr.

WHAT ANIMALS WERE THE ANcestors of birds? To someone reading the popular press of today the answer to that question would seem to be obvious: *the dinosaurs*. In fact, it is not uncommon to read that birds are *living dinosaurs*. Odd as it may seem, that birds may have evolved from dinosaurs is not a new idea. The first scientists to debate the origins of birds came to the same conclusion over one hundred years ago. Why then all the excitement about birds being dinosaurs, you might ask? You would not be alone. Many scientists are asking the same question. Is there really any new data to support a dinosaurian origin for birds, or is this new wave of excitement just the return of an old dogma?

The first fossil bird to receive intense scientific scrutiny was that most famous of all fossil birds, *Archaeopteryx lithographica*, which lived about 150 million years ago during the Late Jurassic. Preserved in the extremely fine-grained lithographic limestone of Solnhofen, Germany, this dazzling fossil was extraordinary in the detail of its preservation, including fine structural details of its feathers. The first discovery of *Archaeopteryx* was a print of a complete feather, 60 millimeters (2⅜ inches) long and 11 millimeters (7/16 inch) wide, found in 1860. From all appearances, this was essentially a modern feather, with two vanes separated by a quill. By itself the feather tells us that *Archaeopteryx* was a bird because feathers are unique characters of birds. They have never been found associated with any other type of animal, fossil or living, although it should be noted that feathers are extremely rare in the fossil record. The feather also tells us that in the Late Jurassic there were flying birds because it is asymmetric in form, with one vane being only about half the width of the other, a clear feature of flight feathers of today.

One month after the feather discovery, the first articulated skeleton of *Archaeopteryx* was found. Not only did the specimen include many bones lying in their natural position relative to one another, there were feather imprints extending out from the forelimbs and tail. But it was not a bird-like tail — it was a long reptilian-like tail with feathers coming off each vertebra! There are now six known specimens of *Archaeopteryx* and it is quite clear that this animal was a mixture of reptilian and avian characters, a true biological mosaic. It had a bird-like head, but a head with teeth and seemingly with reptilian scales instead of feathers. It had a fairly good wing structure that

OPPOSITE ▶
Archaeopteryx was a mosaic of reptilian and avian characteristics. It is considered to be a bird because it had feathers and a furculum. But its bird-like skull appeared reptilian because it had teeth and probably scales. It also had claws on its wings, and a long tail with many caudal vertebrae. *Archaeopteryx* is generally thought to have been a poor flyer, lacking the capability of flapping, wing-propelled flight, although it was probably a good glider. The claws on the wing may have been used for grasping as the bird moved about in vegetation. Painting by Rudolf Freund, 1966, courtesy of The Carnegie Museum of Natural History.

LEFT
This dramatic specimen of *Archaeopteryx* was found in 1877 in a limestone quarry near the Bavarian town of Eichstätt, Germany. It is known as the Berlin *Archaeopteryx* because it belongs to the Humboldt Museum für Naturkunde in Berlin, Germany. Feather impressions, wing claws, the long tail, and many other delicate details are clearly preserved on this specimen. Courtesy of John H. Ostrom, Peabody Museum of Natural History, Yale University.

RIGHT
This feather, first reported in 1861, was the first evidence that birds lived in the Late Jurassic. The asymmetrical shape of the feather, which is thought to be from *Archaeopteryx*, is similar to that seen in the primary flight feathers of modern birds. This is taken as evidence that *Archaeopteryx* was capable of flight. Courtesy of John H. Ostrom, Peabody Museum of Natural History, Yale University.

Not to scale.

ABOVE

The skeleton of *Archaeopteryx* shows many similarities to the skeleton of a pigeon, but many differences are also very obvious. Note the major differences in the structure of the wing, pelvis, and tail. *Archaeopteryx* is not known to have had a bony sternum. Because the pigeon is larger in size than *Archaeopteryx,* it is drawn to reduced scale to facilitate comparison of their skeletons. Symbols: c, carpal; cl, clavicle; co, coracoid; d, digits; f, femur; fi, fibula; h, humerus; i, ilium; is, ischium; mc, metacarpals; mt, metatarsals; p, pubis; py, pygostyle; r, radius; s, scapula; st, sternum; tm, tarsometatarsus; tt, tibiotarsus; u, ulna; v, ventral ribs; I-IV, toes. From *The Origin of Birds* by Gerhard Heilmann. H.F. & G. Witherby, Publishers, London, 1926.

BELOW

The wing of *Archaeopteryx* bore well developed flight feathers, and here its primary feathers are compared to those of a young pigeon (right).The wing of *Archaeopteryx* also had claws at the end of some of its phalanges, a condition seen in modern birds only in nestling Hoatzins (center), birds limited in distribution to the tropical Americas. From *The Origin of Birds* by Gerhard Heilmann. H.F. & G. Witherby, Publishers, London, 1926.

was superficially avian, but which had two carpal digits, or "fingers," that bore claws. It had a furculum, or "wishbone," but not a sternum, or "breast bone." It had an elongated hind limb, with three pedal digits, or "toes," pointing forward and one reversed, or pointing backward, just like birds of today. And of course, it had the long, feathered tail. In many ways *Archaeopteryx* represents a perfect link between reptiles and birds, and its discovery only two years after Charles Darwin published his classic work *On the Origin of Species by Means of Natural Selection*, in which he proposed the theory of evolution, created a sensation.

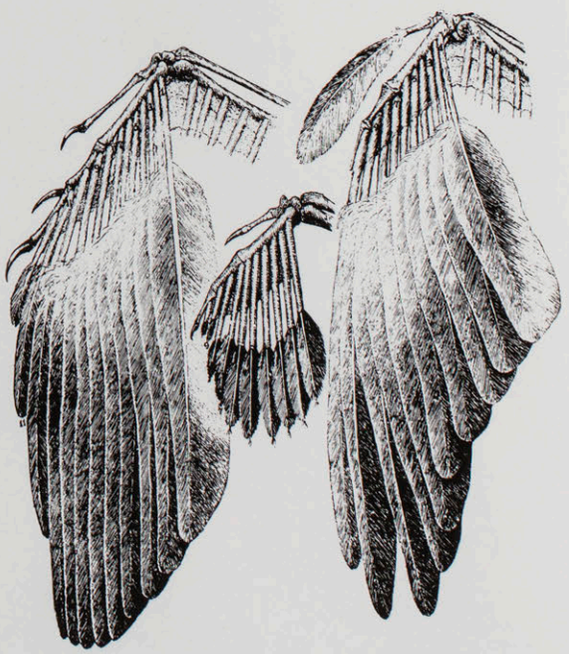
In fact, the discovery of *Archaeopteryx* came so soon after the publication of Darwin's book that it landed right in the middle of the great controversies surrounding the new theory of evolution, and it was immediately thrown up against the dogma of the day. That dogma, of course, was the great force of opinion that refused to accept the possibility of the evolution of biological organisms. This refusal to accept *Archaeopteryx* for what it was is perhaps best illustrated by these words taken from a publication by an influential zoologist of the day named J. Andreas Wagner:

> In conclusion, I must add a few words to ward off Darwinian misinterpretation of our new saurian. At first glance of the [*Archaeopteryx*] we might certainly form a notion that we have before us an intermediate creature, engaged in the transition from the saurian to the bird. Darwin and his adherents will probably employ the new discovery as an exceedingly welcome occurrence for the justification of their strange views upon the transformation of animals but in this they will be wrong.

In short, although the existence of a fossil with a combination of reptilian and avian characters was acknowledged, the message Wagner espoused was: "Don't believe this fossil is an evolutionary link!"

Other scientists of the day, however, did accept *Archaeopteryx* as an animal intermediate between reptiles and birds, and they began the search for its ancestors. What they settled upon were the dinosaurs, fossils of which had been accumulating in collections throughout Europe for some decades leading up to the discovery of *Archaeopteryx*. One of the important factors that led to this conclusion was the recognition that dinosaurs, *Archaeopteryx*, and birds were bipedal. That is, terrestrial locomotion is provided by the two hind limbs only. But there were other features in common as well.

Birds arose from a large group of reptilian animals called *archosaurs*, or if you choose to consider birds as living dinosaurs then they would be living archosaurs. The only, or only other, living archosaurs are the crocodilians, but extinct archosaurs include all of the dinosaurs, the pterosaurs, and several other,

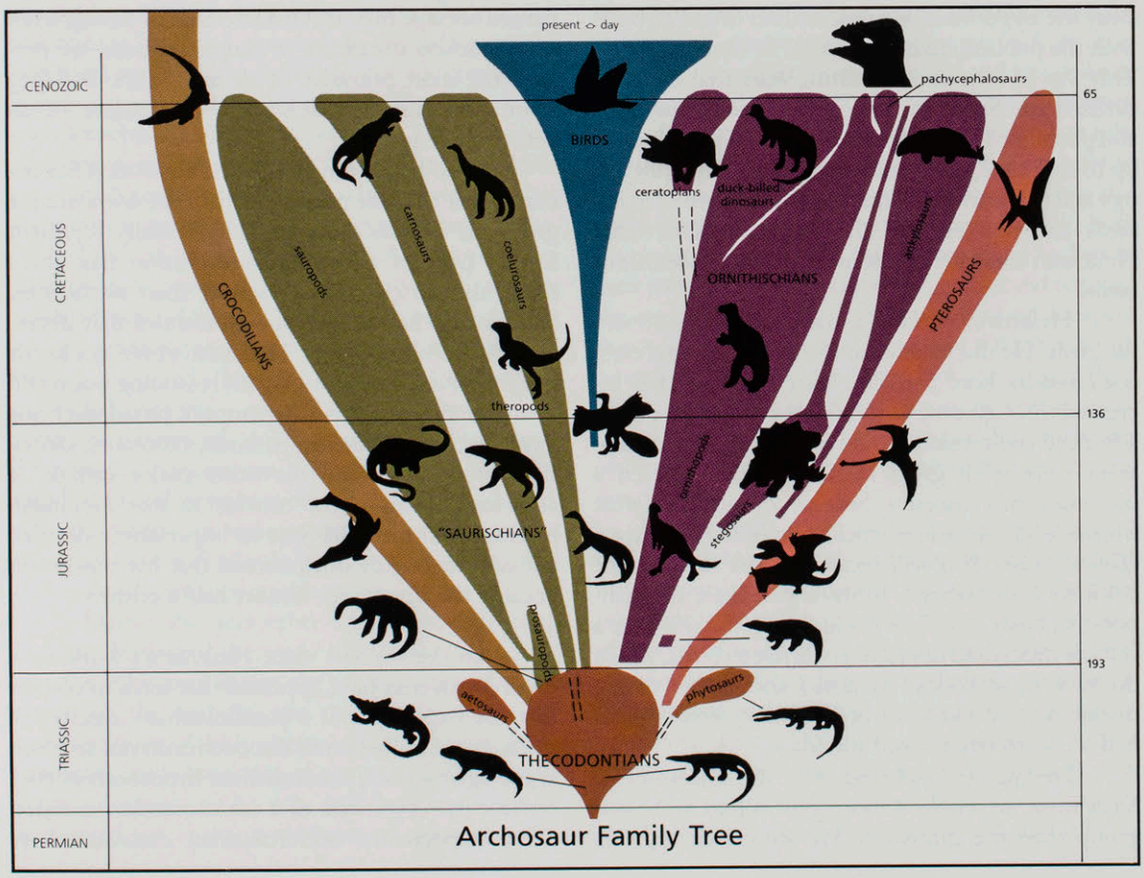


lesser known groups. Archosaurs as a group are technically defined by a series of skeletal specializations. One set of skeletal features resulted from the animals assuming a more upright posture and a more effective fore-and-aft movement of the limbs, as opposed to, for example, what is seen in turtles, which are not archosaurs. All archosaurs share a diapsid condition of the skull, which means that there are two vacuities, or holes, in the roof of the back of the skull. These vacuities serve to provide room for the bulging of the jaw musculature and to lighten the skull without weakening it. Moreover, all archosaurs and birds have an antorbital fenestra, which is an opening in the skull forward of the orbit, or eye socket. This opening is thought to have perhaps provided space for a gland, such as a salt gland, at an early evolutionary stage of archosaur evolution. The search for avian ancestors must then be restricted to early archosaurs.

Dinosaurs, because they were bipedal and shared other archosaurian features with birds, were thus reasonable candidates as avian ancestors. Within the dinosaurs *Archaeopteryx* most closely resembles the bipedal group called theropods. Theropods include the large, heavily built carnosaurs, of which *Tyrannosaurus rex* is a representative, and the coelurosaurs. The coelurosaurs were among the earliest of all dinosaurs, and they were, for the most part, small, lightly built dinosaurs that appear to have been well adapted for cursorial locomotion. The resemblance of *Archaeopteryx* to advanced coelurosaurs is so great, in fact, that one specimen of *Archaeopteryx* was long mistaken for a juvenile specimen of the coelurosaur *Compsognathus*, which is found in the same Solnhofen limestone deposits. Thus, on the basis of the fossils then available, over the course of the final decades of the nineteenth century and the first few decades of the twentieth century the consensus of scientific opinion gradually consolidated around the hypothesis that birds had, indeed, evolved from dinosaurs. By the 1920s this hypothesis was firmly entrenched and could be considered as the dogma of the times.

Basic archosaur skull as represented by *Compsognathus*

Birds, dinosaurs, and crocodiles all have what is known as a diapsid skull. In this condition, two vacuities exist in the skull roof. Another defining feature of an archosaur skull is the presence of an antorbital fenestra. After "What Is a Dinosaur?" in *Carnegie's Dinosaurs* by Helen J. McGinnis. Pittsburg: Carnegie Institute, 1982.



Most of the major groups of archosaurs can be traced back through the fossil record to an origin within the thecodonts. The fossil history of birds, however, does not extend that far back in time. The lack of fossil birds older than *Archaeopteryx* is a definite disadvantage to those who would also link the origin of birds to the thecodonts. After "The Family Tree of the Archosaurs," in *A New Look at the Dinosaurs* by Alan Charig. New York: Facts on File, 1985.

The coelurosaurian dinosaur *Compsognathus longipes* lived at the same time as *Archaeopteryx*, and it was also preserved as a fossil in the Solnhofen limestone. Those who think birds evolved from dinosaurs consider *Compsognathus* to be a close relative of birds. *Compsognathus* was bipedal, and it was probably a very agile, cursorial dinosaur. From *The Origin of Birds* by Gerhard Heilmann. H.F. & G. Witherby, Publishers, London, 1926.

In 1926, however, Gerhard Heilmann, building on the work of a few pioneers before him, swept away the hypothesis of a dinosaurian origin of birds with the publication of his book *The Origin of Birds*. This was an exhaustive scientific work that included detailed studies of the major groups of fossil birds and postulated dinosaurian ancestors of birds known up to that time, comparative studies of the embryology and the anatomy of many organ systems of living birds and reptiles, and the presentation of what Heilmann concluded must have been the ancestors of birds.

Heilmann rejected a coelurosaurian ancestry for birds. He did so reluctantly, admitting that early coelurosaurs bore a resemblance to birds that increased through time to the point at which the most advanced coelurosaurs could be told from *Archaeopteryx* only with great difficulty. He rejected a coelurosaurian ancestry because of one fact that overrode all similarities: coelurosaurs did not have a clavicle bone. You will recall that the clavicle, the collarbone in humans, forms the furcula, or wishbone, of birds. So, if the coelurosaurs did not have a clavicle they could not have given rise to birds, which do have these bones. As noted above, one of the distinctive bird-like features of *Archaeopteryx* is that it had a completely formed furcula.

Heilmann concluded that the ancestors of birds must lie within a more generalized archosaur group than the dinosaurs. He settled on a group called the Pseudosuchia, or "false crocodiles," which were a subgroup of the Thecodontia. Thecodonts, so named because they are characterized by having teeth set in sockets instead of in simple grooves, are perhaps the most primitive of all archosaurs, but they share with all later archosaurs the feature of an antorbital fenestra.

Since Heilmann completed his work it has become clear that the pseudosuchians are not a unique group of animals. Instead, they actually represent several lines of archosaurian evolution that share many skeletal characters. Despite their similarities, each lineage has its own special features that distinguish it from the others. Heilmann could not know this, however, and following his reasoning one could postulate that separate subgroups of pseudosuchians gave rise, independently, to birds, dinosaurs, crocodiles, pterosaurs, and the other major groups of archosaurs. This is the conclusion that Heilmann reached, and his work was so impressively detailed and so thoroughly documented that his conclusion became the dogma for almost half a century.

In the decades since Heilmann's work, new fossil discoveries have appeared that seem to contradict the hypothesis of a pseudosuchian ancestry of birds. Some of these new discoveries do not so much argue against the pseudosuchian hypothesis as they remove the objections to a coelurosaurian ancestry. Most importantly, coelurosaurian dinosaurs have

been found that have clavicles, and some are reported to have their clavicles fused into bird-like furcula. The fact that these bones are present in some coelurosaurs removes Heilmann's principal objection to a coelurosaurian ancestry for birds. Does this mean that the scientific community has now flipped back and whole-heartedly embraced the pre-Heilmann dogma of a dinosaurian ancestry for birds?

Not quite. Beginning in the early 1970s there was a broad renewal of interest in the origin of birds, prompted in part by a proposal that birds shared a common ancestry with the ornithischian dinosaurs. The ornithischian dinosaurs are what are known as the "bird-hipped" dinosaurs, as opposed to the other main line of dinosaurs, the saurischian, or "lizard-hipped," dinosaurs. These names are derived from the orientation of the pubis, or "seat bone," of the pelvis, and the pubis of the ornithischian dinosaurs bears a fairly close resemblance to that in birds. The proposal for a common ancestory between birds and ornithischian dinosaurs has not garnered much support, however.

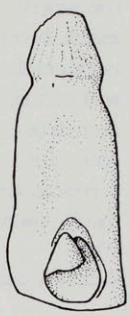
A second proposal from the early 1970s, the crocodilian hypothesis, attempted to demonstrate a relationship between crocodiles and birds. This is actually a very unfortunate name for the hypothesis because it does not intend to suggest that crocodiles gave rise to birds, a suggestion that would probably strike most people as rather far-fetched. Rather, the crocodilian hypothesis proposes that a single ancestral lineage split and gave rise to crocodiles on the one hand and birds on the other. For all intents, this is only a specialized variant on the more generalized pseudosuchian ancestry hypothesis. The strongest proponent of this hypothesis today is Dr. Larry Martin of the University of Kansas, who has put together some very interesting facts to support his arguments.

One of Martin's arguments concerns the similarities between the teeth of early birds and the teeth of crocodilians. The teeth of both of these groups resemble each other in external morphology, having a tapered, flattened crown set off from an expanded root by a constriction. All known bird teeth are unserrated, as are most crocodilian teeth. Theropod dinosaurs, on the other hand, have serrated teeth and straight roots without a constriction. Also the manner of replacement and implantation of the teeth is very similar in birds and crocodiles, and differs from that seen in dinosaurs.

Martin also sees other significant differences between birds and theropod dinosaurs, such as the way the ankle joint forms, the positioning and orientation of the scapula, the manner in which the quadrate bone of the lower jaw articulates against the braincase, and characters of the pelvis. These characters all appear to be very real facts and must be accounted for in any hypothesis of avian ancestry. These data cannot be wished away by supporters of a dinosaurian ancestry of birds any more than *Archaeopteryx* could be wished away by the early anti-Darwinians.

Also in the early 1970s, Dr. John Ostrom of Yale University began his detailed work on the question of avian origins. Ostrom, perhaps the most persuasive advocate of a theropod dinosaur ancestry of birds, has reiterated many of the early discussions of a coelurosaurian ancestry for birds, as well as having provided a wealth of new information and interpretations. His arguments are not conclusive, however. There are no characters that irrefutably unite coelurosaurian dinosaurs with birds.

Theropod dinosaur, *Megalosaurus*



Alligator

Archaeopteryx lithographica

One of the characters used to suggest a relationship between birds and crocodilians is the similarity in the shape of their teeth. The crowns of their teeth are similar, and they share a constriction of the tooth between the crown and its root. The teeth of both birds and crocodiles differ quite significantly from the teeth of dinosaurs, which are more blade-like and do not have a constriction dividing the crown from the root. Not only is the overall shape similar, but the manner of emplacement of the teeth is similar in birds and crocodiles and different from how it occurred in dinosaurs. After restorations in Larry Martin, "The Relationship of *Archaeopteryx* to Other Birds," *The Beginnings of Birds, Proceedings of the International Archaeopteryx Conference Eichstätt, 1984*, p. 178 (left and center), and Larry Martin, "Origin of Birds and Avian Flight," *Current Ornithology*, 1983, vol. 1, p. 115 (right).

There is no question but that the skeletons of the last of the coelurosaurs bear a great resemblance to the skeletons of *Archaeopteryx*. As you go back in time, however, these resemblances are less and less striking. The question that arises is whether or not the observed similarities are a result of an ancestor-descendant relationship or convergence. By convergence we refer to the evolution toward the same condition by two distinctly separate lineages of animals. For example, both mammals and crocodiles have teeth set in sockets in their jaws, but their last common ancestor did not; i.e., the condition of rooted teeth was evolved independently in the two lineages. Similarly, Old World vultures and New World vultures look very much alike, feed in very similar ways, and have many similar osteological features, but they belong to two different orders of birds and evolved in a convergent fashion to their present form.

Currently, some paleontologists trying to build on Ostrom's work and most strongly pushing for a coelurosaurian ancestry for birds take the position that convergence could not account for the observed similarities between coelurosaurs and *Archaeopteryx*. It is their view that convergence is insignificant and unimportant as a biological phenomenon. To the contrary, convergence is such a widely recognized and documented biological phenomenon that it simply cannot be ignored. Just because a very advanced coelurosaurian dinosaur bears

a close superficial resemblance to a very primitive bird does not mean that they are related.

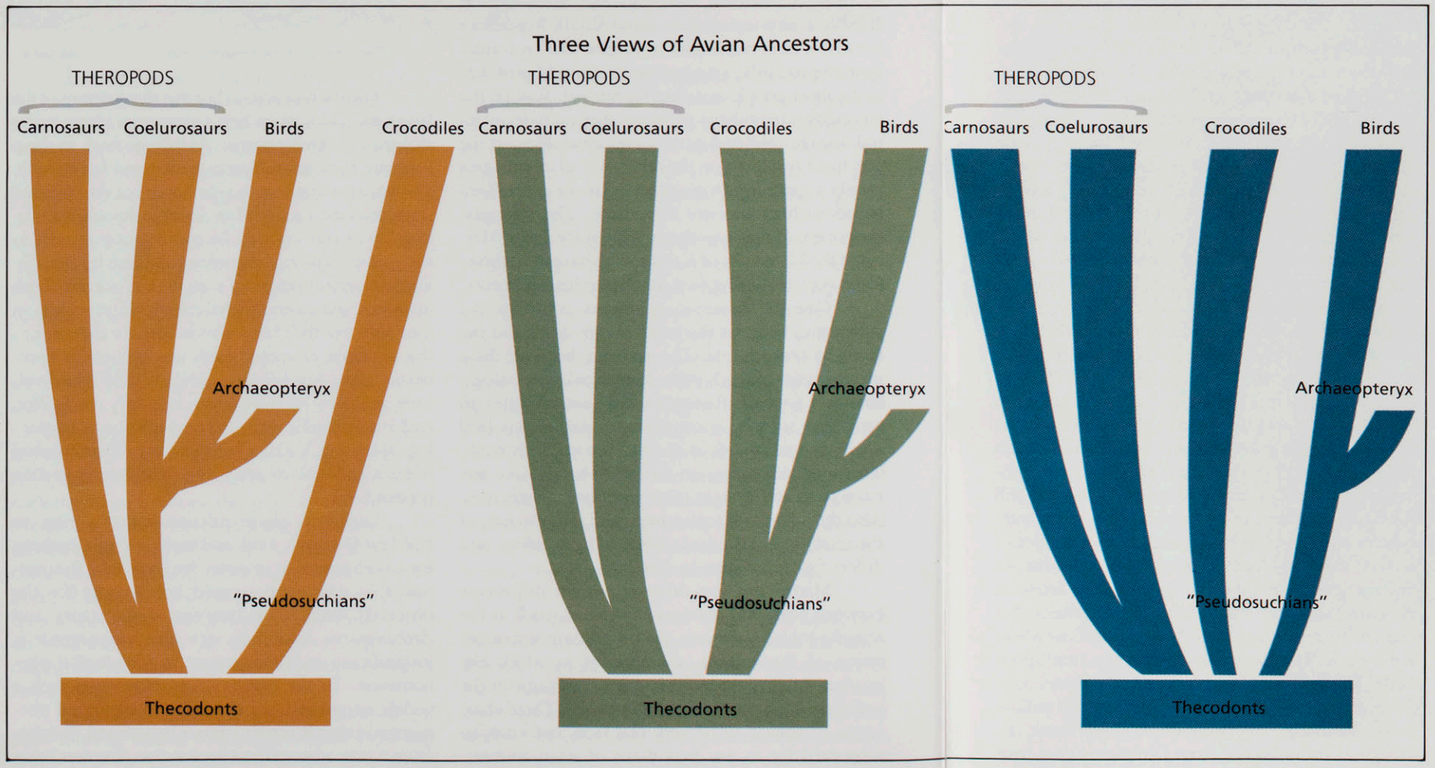
If the only significant difference between *Archaeopteryx* and coelurosaurs is the fact that *Archaeopteryx* had feathers, should we not also see feathers in at least some of the advanced coelurosaurs? After all, the feathers of *Archaeopteryx* are modern flight feathers, indicating that the lineage leading to *Archaeopteryx* possessed feathers for some time prior to *Archaeopteryx*. Unfortunately for the dinosaurian ancestry hypothesis, no feathers have ever been found associated with any dinosaur. This includes the purported close coelurosaurian relatives of *Archaeopteryx* that have been found in the same Solnhofen limestone where feather impressions are known from all specimens of *Archaeopteryx*, albeit it in some cases much better preserved than in others. This is not because the effort has not been made. Ostrom did make an exhaustive study of the *Compsognathus* specimen from Solnhofen in search of feathers, but he could find none. In this case, we know the sediments were capable of preserving feathers, so their absence can be taken as fairly good, albeit negative, evidence that the advanced coelurosaurian dinosaur *Compsognathus* did not have feathers.

The question of feathers, because of their insulation value, also bears on another reason why some individuals are pushing to reestablish the dogma that birds are dinosaurs in disguise. Some paleontologists think dinosaurs were homeothermic (hot-blooded), and, like birds and mammals, maintained a constant body temperature. Although arguments promoting hot-blooded dinosaurs have been around for many years now, they have not proven very convincing. How much easier it would be for the proponents of this hypothesis if they could just convince everyone that birds were dinosaurs, because then *ipso facto* dinosaurs would become hot-blooded! Is it any coincidence that perhaps the most vociferous proponent of hot-blooded dinosaurs is also the most vociferous in claiming that birds *are* dinosaurs?

Clearly, the origin of birds has not been resolved. On one hand, the arguments for a dinosaurian origin of birds are inconclusive, at best. Most of the similarities between coelurosaurian dinosaurs and *Archaeopteryx* can be explained by convergence. Indeed, the similarities between the advanced coelurosaurs and *Archaeopteryx* must be explained by convergence because, as even the proponents of a dinosaurian ancestry admit, if birds did evolve from dinosaurs, they must have split away long before their purported coelurosaurian ancestors achieved their bird-like form. Regardless of the merits of the arguments for a dinosaurian origin of birds, however, the claims that birds *are* dinosaurs are baseless.

But, the arguments for a pseudosuchian origin of birds are also inconclusive. Nonetheless, I personally lean toward this side of the debate because I see stronger supporting arguments, more facts, and less noise there. This is not to say that I completely support the crocodilian ancestry hypothesis, however. The oldest known fossils that can be considered members of the ancestral stock that gave rise to modern crocodiles appear to me already to have evolved specializations beyond the point at which they could have given rise to birds.

In fact, I suspect that the true ancestral lineage of birds has yet to be discovered. What are needed are more fossils, especially bird fossils that are older than *Archaeopteryx*. We must remember, after all, that *Archaeopteryx* represents a dead end lineage from the main evolutionary line of birds. It was, we might say, an evolutionary experiment in being a bird. One purported fossil bird has been reported from Upper Triassic rocks in Texas, rocks that are some 60 million years older than *Archaeopteryx*. This fossil has yet to be described scientifically, however, and thus cannot contribute to the debate on avian origins. We must remember that the ancestors of birds were probably very small, arboreal animals. These kinds of animals are notorious for leaving poor fossil records because their remains are so rarely preserved in sediments. Our knowledge of the history of fossil birds is rapidly increasing, however, so perhaps we shall soon have a clearer understanding of what animals were the true ancestors of birds. For the moment, the abundance of facts is preventing the establishment of a new dogma.



There are three primary hypotheses regarding the origin of birds. In one, the coelurosaur hypothesis (left), birds are thought to have evolved from coelurosaurian dinosaurs. In another, the crocodile hypothesis (center), birds are thought to have evolved from the same ancestral lineage as that which gave rise to the crocodilians. In the third, the pseudosuchian hypothesis, birds are thought to have evolved directly from the thecodonts quite apart from the lineages leading to dinosaurs and crocodiles.

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Polar Dinosaurs Down Under

by Jennifer Monaghan, Tom Rich, and Pat Rich

ONE HUNDRED AND SIX MILLION years ago, during the Early Cretaceous Period when most of the great southern supercontinent of Gondwana was breaking apart, Australia was still docked like a great ship alongside Antarctica. Australia was far to the south of its present position; the southeastern coastline of present-day Victoria was well within the Antarctic Circle, at a latitude of 75° to 85°S. A broad valley stretched southward to Antarctica, its floor a massive floodplain criss-crossed by a braided river system. Lakes and occasional swamps broke the monotony of this seemingly endless expanse. Across this area Australia and Antarctica would part company, with a seaway invading like an opening zipper, some 10 million years later. This geologic "separation" would leave Australia an isolated continent drifting northwards, a peregrination still in progress today. Creeping northwards at nearly 5 cm (2 inches) per year, the antipodean continent will eventually collide with southern Asia, and faunas and floras will battle for supremacy.

Despite its high latitude during the Early Cretaceous, the southern coast of Victoria did not experience temperatures as low as those of comparable latitudes today. Researchers studying the oxygen isotope content of carbonate concretions in the sandstones deposited on this vast floodplain suggest that the mean annual temperature was somewhere between −6° and +5°C, near the freezing point of water. But regardless of the temperature, because of the high latitude, the animals and plants living during the Early Cretaceous in southern Victoria would have had to cope with perhaps three to five months of nearly total darkness in this land of the summer midnight sun. Environmental conditions, then, would have been very different than they are today, with this same area now lying at a latitude of about 38°S.

The age of the fossil-bearing rocks has been estimated by two quite different techniques. The first, fission-track dating, calculates the passage of time by determining the amount of radioactive decay that has occurred in the minerals from a rock sample since its formation. The second method utilizes the fossil pollen and spores preserved in the rocks. Different species have occurred over distinct time ranges, and once these are plotted on a regional or international scale, local areas can be correlated by recording appearance and disappearance of pollen and spore types.

Both the sediments and the plants entombed in them paint a picture of the Otway district of southern Victoria at this time as a humid and well-watered land, cool and nontropical, where ginkgoes (Maiden Hair trees), podocarps, and araucarian conifers, as well as club mosses, seed ferns, horse tails, and tree ferns, flourished. Today, the area has a cool, temperate climate with a mean annual rainfall of 100 to 140 cm (40 to 55 inches). Although rainfall is about the same now as it was during the Cretaceous, environmental conditions in the Otway area have changed and so has the vegetation. Today the forests that blanket the hillsides are composed of a variety of eucalypts, acacias, and Austral grasstrees (*Xanthorrhoea*), to name but a few. Tree ferns, and a variety of other ferns, remain as relict from the ancient flora, but most of the old Cretaceous plants are gone.

Little was known of the ancient fauna, particularly the terrestrial vertebrates, until relatively recently. The claw of a dinosaur, thought to be similar to the theropod *Megalosaurus*, and a single lungfish tooth were recovered from the Gippsland Basin at the beginning of this century, but despite further efforts, nearly 80 years passed before anything more of consequence was found. In the late 1970s, two determined university students were lucky enough to find several bones very near the same site that produced the fish and dinosaur remains. The new finds included the astragalus (ankle bone) of a theropod dinosaur very similar to *Allosaurus*, and this prompted a small group of paleontologists to systematically prospect along this southern coast in the Australian summer of 1979-80. During this time, they walked a distance of 320 km (200 miles) east and west of Melbourne, checking the Cretaceous outcrops of sandstone and clay conglomerates along the shore platform for fossils. Several sites were located: Point Lewis, Point Franklin, and Eric the Red. A fourth site, in the western part of the Otway Ranges, was rich enough to warrant a full-scale excavation. This was carried out in 1984 with a volunteer crew that mainly consisted of the Friends of the Museum of Victoria and students from Monash University in Melbourne. The excavated site now bears the name of Dinosaur Cove on official topographic maps of the area, in recognition of the dinosaurs found there.

One hundred and six million years ago, the Dinosaur Cove area supported a wide variety of vertebrates, including lungfish and bony fishes, turtles and pterosaurs, plesiosaurs and small theropod dinosaurs. Even at this time, Australia, although still physically attached to Antarctica, was apparently experiencing some isolation, and distinctive species evolved there, evidently in response to land masses drifting apart. A number of the specimens found in the Dinosaur Cove area display characteristics that suggest isolation from assemblages found elsewhere in the world. The rare flying reptile (pterosaur) specimens, for example, have a vertebral construction characteristic of forms no younger than 200 million years. Similarly, labyrinthodont, amphibians, although as yet unknown from Dinosaur Cove, have been found at the Punchbowl in the Strzelecki Range

OPPOSITE ▶
Restoration of *Leaellynasaura amicagraphica* (foreground) and *Atlascopcosaurus loadsi* in the cool-temperate rainforest of southern Victoria 106 million years ago.

PETER SCHOUTEN

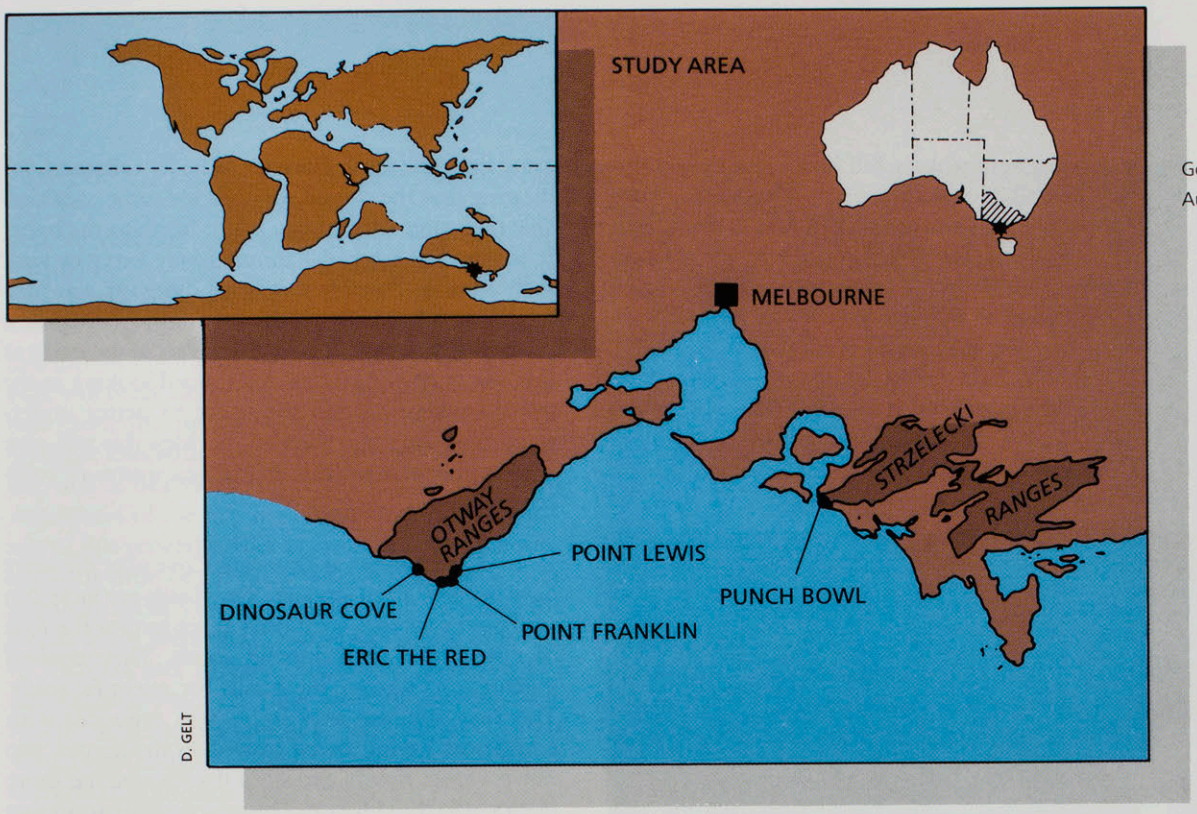
PETER SCHOUTEN 88

J. MONAGHAN

Eucalypts and Austral Grasstrees that blanket the hillsides over Dinosaur Cove today.

of the Gippsland Basin, paradoxically in Cretaceous deposits, whereas in other parts of the world they have been found in deposits no younger than Jurassic age (160 mya). These large carnivorous forms, very likely counterparts to crocodiles, had their heyday 200 million years ago in the late Paleozoic and Triassic, but for some reason had become extinct for the most part after that time. The fact that their remains were found in these Cretaceous deposits implies that they endured on this fragment of Gondwana for another 20 or 30 million years after they had died out in the rest of the world.

Also anomalous are the lungfish, which today are present only in environments where temperatures never dip below 10°C. (This modern tolerance range, however, may be very much more restricted than in the past.) Plesiosaurs, which are long-necked aquatic reptiles, most commonly have been found in marine deposits, but the specimens found in southern Victoria appear to have been freshwater dwellers in the



Gondwana 106 million years ago. Australia today and enlarged study area.

same fashion as marine mammals such as dolphins, which include species confined to the freshwater Amazon and Ganges rivers today.

But by far the most abundant finds to date of vertebrates in the Southern Victorian region during this particular time interval have been three or four endemic species of small bird-hipped dinosaurs that were rather like kangaroos in overall appearance. They belong to the family Hypsilophodontidae, which occurs elsewhere in the world but which is represented by endemic species and genera both at Dinosaur Cove and at other locales within Australia.

The hypsilophodontid dinosaurs from Dinosaur Cove are small, the largest the size of a small human adult and the smallest only as tall as a bantam chicken; one had large eyes and extremely well-developed optic lobes, which hint that it was well-adapted to the long periods of darkness. Being of such small size, it is unlikely that they were able to migrate far enough north to remain with the "light line" in winter. If they did remain the year round in southern Victoria, feeding would apparently not have been a problem, for much of the vegetation, including the forest trees, was not deciduous. There would have been plenty of fodder for the dinosaur herds.

Did these polar dinosaurs hibernate? Their size would certainly have made it feasible. At present, it is impossible to tell which of these three scenarios is correct: migration, hibernation, or active participation in the polar winter community. The big eyes and large optic lobes of the one species hint at the latter interpretation but by no means prove it beyond reasonable doubt.

To date, some 2,000 specimens of hypsilophodontids have been collected, many small fragments gathered along with bones, isolated teeth, tooth rows, and two partial skeletons. The most well-preserved elements are the remains of limb bones (mainly femora) and teeth representing small hypsilophodontid dinosaurs. The first partial skeleton and skull were found toward the end of the 1987 dig. This small dinosaur (perhaps only 50 cm [20 inches] tall), with its large eyes and brain, was named *Leaellynasaura amicagraphica* after a schoolgirl who had been a member of the excavation crew, and in honor of the National Geographic Society, which has largely funded the project, and the Friends of the Museum of Victoria, for their encouragement and support. It is most likely that this skeleton of *Leaellynasaura amicagraphica* is a young dinosaur, based on comparison of femoral sizes within the species. In fact, many of the specimens from the southern Victorian sites are juveniles, indicating that for at least a part of the year, that area was a dinosaur nursery.

It is now apparent that at least two or three other hypsilophodonts existed in this area. One has been named *Atlascopcosaurus loadsi*, in honor of the Swedish Atlas Copco mining equipment company

and its former manager Bill Loads, for their support with machinery and equipment. The proper name of a third Victorian hypsilophodontid is *Fulgurotherium australe*. This species was first found farther north in the opal-producing rock sequences of Lightening Ridge in western New South Wales.

The second partial hypsilophodontid skeleton (as yet unidentified as to genus), which has only very recently been prepared, includes the foot, tibia, femur, part of the pelvis, and several vertebrae. An associated tibia (shin bone), which almost certainly came from the same dinosaur, is badly calloused, indicating that the animal survived for some considerable time after sustaining a major break to the bone. It is rare that a bipedal animal today survives with such a break. Possibly this small dinosaur was protected by a herd to which it belonged — again a conjecture that cannot be proven. Part of the study of this specimen will be directed toward looking at the microstructure around the break to better understand how the bone mended; perhaps this will give insight into whether this animal was warm- or cold-blooded.

S. MORTON

Partial skeleton of a small hypsilophodontid dinosaur found at Dinosaur Cove. Note broken leg.

Excavations at Dinosaur Cove over the years have been far from smooth. The fossils are locked in very hard rock that is exposed at sea level at the foot of a steep cliff with difficult access. This required ingenuity to recover the fossils for scientific study. The first summer expedition was arduous, with equipment having to be carried from the cliff top down a long, rough, and steep track across the shore platform to the cliff face. This was done by strapping jackhammers, rock saws, and drills to long bamboo poles that the volunteers carried on their shoulders. In subsequent years, this problem was eased by sporadic helicopter support. Finally a "flying fox" (not an animal but a mechanical cable-pulley system) was constructed from the cliff top to the shore platform below. With this apparatus all equipment can be winched in and out, and fossil-bearing rock can be brought out from the site to the camp each day.

Besides the difficulty of access, there was also the problem of the sea itself. The tunnels that have been excavated are nearly at sea level. In the first year giant waves battered the fossil site one night, scattering pieces of drilling equipment worth several thousand dollars all along the cove beach. Fortunately, no one was working that night, and most of the equipment was later recovered from tide pools. After this incident, the crews were much more aware of the danger of high seas and freak tides; nowadays a crew member is often placed on wave watch to keep track of incoming surf and warn others in case of danger.

The fossil-bearing sediments, mainly the cement-hard remains of old stream channel deposits that have resulted from broken levees alongside major rivers, have meandered off in unexpected and almost inaccessible directions, making it necessary to turn the excavation into a full-scale mining operation requiring a variety of air compressor-driven drills and rock-breaking equipment — and ultimately explosives — to remove the overburden. In following the paleostream channel, three productive sites within Dinosaur Cove have been excavated. At the Slippery Rock site, so far the richest of all the sites known, two main drives have been cut into the cliff, with two additional cross tunnels connecting them — an enor-

mous task. The tunnels have been driven into the cliff face above the fossiliferous layer, and then, using delicate methods (geology picks and crow-bars), paleontologists have carefully prised out the fossiliferous rock below.

Often these fossils have been preserved at the juncture of slightly different sediment types, and the rock will break along this plane, revealing some treasure from the past. One of two partial skeletons found at Dinosaur Cove was recovered in this manner, and it beautifully exposed the skull and brain impression of the tiny hypsilophodontid, *Leaellynasaura*. But generally, rock is brought out of the tunnel with little or no bone showing, and it is later manually broken with a hammer to be checked for fossils. Final preparation takes place at the Museum of Victoria and Monash University (Melbourne), and it is tedious, very time-consuming work done mainly with needles and tiny "jackhammers" called vibratools. Some specimens can require weeks or even months of preparation time.

The southeastern coast of Australia has proven to be one of marked paleontological importance. It is one of the few polar dinosaur sites in the world and clearly demonstrates that dinosaurs were able to live at high latitude and in extended periods of darkness for some considerable time, developing a high degree of endemism. For this reason alone, the chance to understand this unusual community of plants and animals, living in an environment that has no modern counterpart, justifies all the hard work and financial investment.

A prime minister of Australia once said, "Life wasn't meant to be easy." Nor was dinosaur digging.

Jennifer Monaghan is a research assistant in the Earth Sciences Department at Monash University.

Dr. Tom Rich is Curator of Fossil Vertebrates at the Museum of Victoria, Melbourne. His interests are in Mesozoic vertebrate faunas.

Dr. P. Vickers-Rich is a Reader in the Earth Sciences and Zoology Departments at Monash University, Clayton, Victoria, Australia. She and her students are interested in the origin and evolutionary patterns of the Australian backboned animals and their environments over the past 400 million years, in particular with respect to those of Southeast Asia and South America.

Atlascopcosaurus loadsi rearmost cheek-tooth, about 13 mm long, unerupted.

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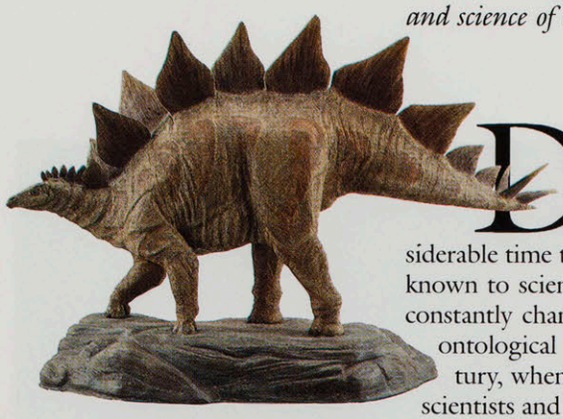
White, M.E., *The Greening of Gondwana*. Australia: Reed Books, 1986.

Dinosaurs Past and Present

The Natural History Museum's traveling exhibition on the art and science of depicting dinosaurs returns to Los Angeles



Model of *Stegosaurus stenops* by Stephen Czerkas.

OPPOSITE ▶
Daspletosaurus and *Styracosaurus* by John Gurche.

"What Happens When *Apatosaurus ajax* Seeks Aquatic Refuge from *Allosaurus fragilis*" by Gregory Paul.

DINOSAURS HAVE VIVIDLY CAPtured our imagination for more than a century. During the considerable time that these "terrible lizards" have been known to science, our concept of the dinosaur has constantly changed in response to advances in paleontological research. In the mid-nineteenth century, when paleontology was still in its infancy, scientists and artists had to cope with the available fragmentary evidence to interpret the appearance of these exciting but sometimes bizarre-looking animals. Since then new pieces of the scientific puzzle have continually become available to aid in the reconstructive process. These have been interpreted according to prevailing ideas of reptilian physiology and anatomy with varying degrees of success. With one or two notable exceptions, only during the second half of the present century has the desirability of contrasting dinosaur remains with functionally similar representatives of birds and mammals become widely appreciated and standard practice.

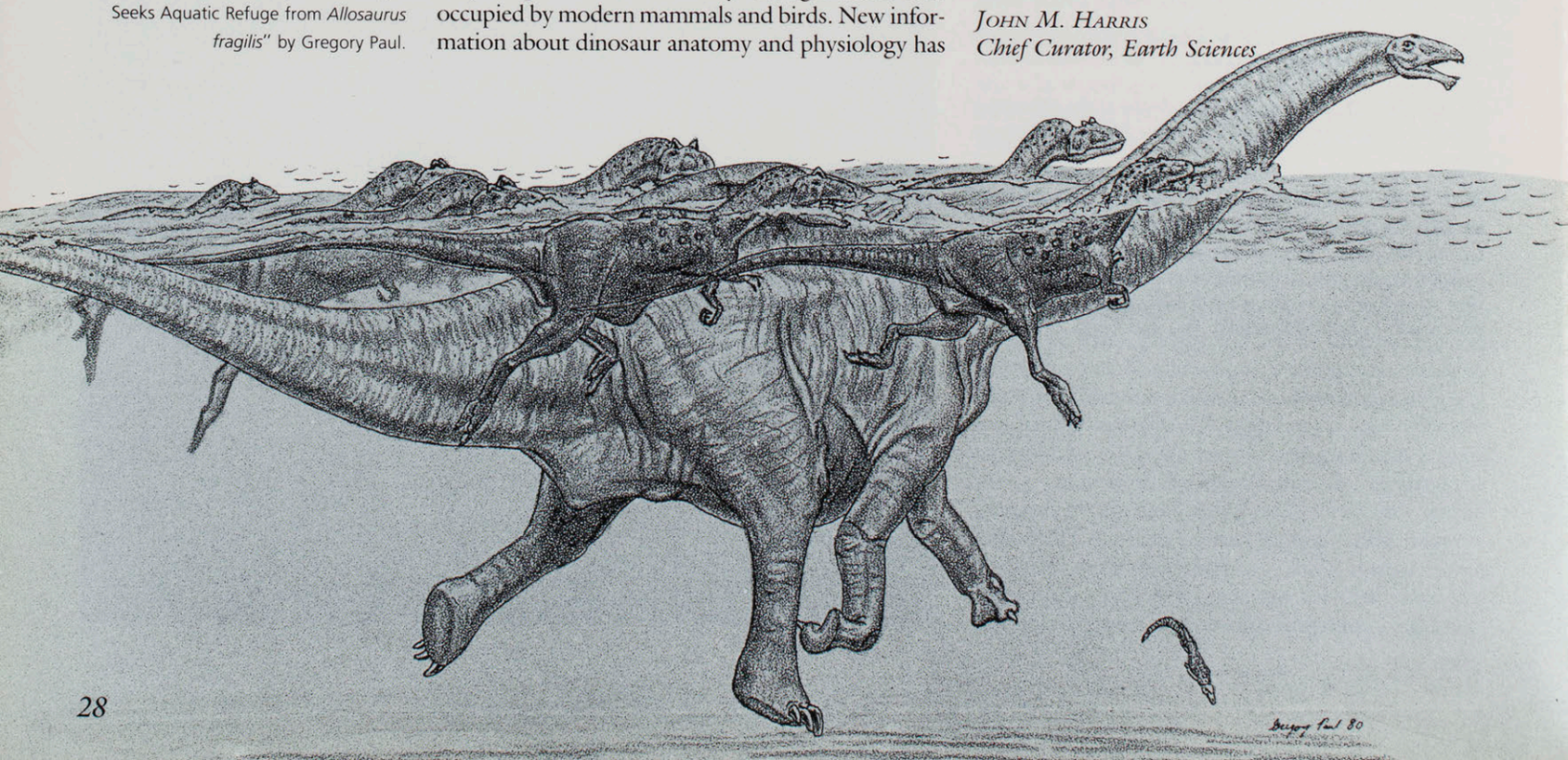
Today a new generation of artists, working within the framework of rigorous analyses provided by their scientific colleagues, has helped redefine our understanding of these fascinating animals. The lumbering giants envisaged by the artists of yesteryear have ceded place to dynamic creatures, both large and small, that are now shown posed naturally in realistic settings.

Perhaps the most striking change to occur in the restorations is in the depiction of body posture. The emerging new look is one of anatomically correct, sleeker, and more varied animals that successfully adapted to almost every ecologic niche now occupied by modern mammals and birds. New information about dinosaur anatomy and physiology has indicated that some dinosaurs were capable of rapid locomotion and may have been warmblooded. New evidence about dinosaur skin and armor has added to the realism with which these creatures may now be portrayed. Careful study of the paleobotanic record, and of the geologic context in which the fossils were found, has aided accurate reconstruction of the scenes in which the dinosaurs have been depicted.

In 1986, Sylvia Czerkas organized an exhibition for the Natural History Museum entitled Dinosaurs Past and Present, which illustrated how drastically ideas about the appearance and behavior of dinosaurs have changed. After traveling to 14 museums in the United States, Canada, and Great Britain, this exhibition is returning to the Natural History Museum in June of 1991. It is on display, along with a second exhibition — Dinosaurs — A Global View (sees page 6–13) — through August 25.

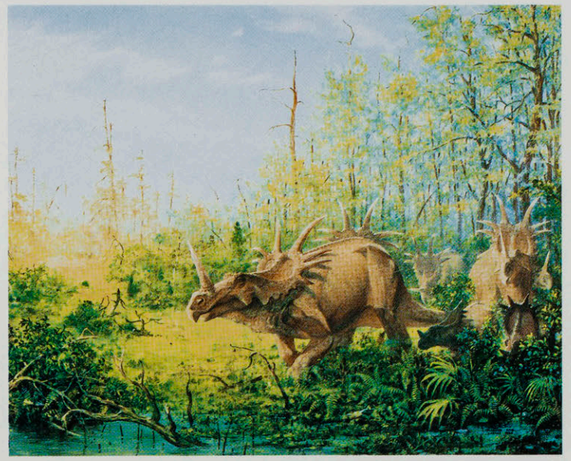
The museum also convened a symposium of leading scientists and artists and published their groundbreaking papers in two volumes named after the exhibition. Volume I of *Dinosaurs Past and Present* discusses how fossil evidence is interpreted by paleontologists and artists to reconstruct dinosaurs and the environments in which they lived. Volume II provides examples of how physical evidence can be interpreted, correctly or incorrectly, in the restoration of extinct animals, and sheds additional light on the end of the age of dinosaurs. The books reflect the exhibition in that they celebrate 150 years of collaboration between paleontologists and some of the best dinosaur restoration artists in the world.

JOHN M. HARRIS
Chief Curator, Earth Sciences



©GURCHE 85

Kritosaurus incurvimanus by Vladimir Krb. This restoration is based on information obtained in the recovery of a specimen found entangled in the roots of a fossilized tree in Dinosaur Provincial Park in southern Alberta. When the hadrosaur died 75 million years ago, its carcass floated downstream until it came to rest against a tree at the bank. In the mud under the body, the dinosaur's skin left impressions which were preserved in the fossil rock. As the body decomposed, some of the bones were washed further downstream before becoming buried in the sand.



Styracosaurus albertensis, a restoration by Vladimir Krb. A large male is shown, followed by babies, an adult female, and some juveniles.

NEXT PAGE ▶

"Cool Weather," a restoration of *Camptosaurus* by William Stout.

Remember the Children

BETWEEN 1939 AND 1945, UP TO 1.5 million children were killed under Nazi rule in Germany and occupied Europe. Tens of thousands of these child victims were Gypsies and handicapped children, and the great majority were Jewish.

"Remember the Children" is a special exhibition focusing on the fate of children in the Holocaust. Organized by the U.S. Holocaust Memorial Council, it is designed both for children and adults, and tells the story of Daniel, a fictional Jewish child whose experiences are a composite of those of actual Jewish children of the era. The exhibition will be on view at the Natural History Museum from June 15 through September 22, 1991.

The United States Holocaust Memorial Council has collected diaries and photographs of children who were Holocaust victims and survivors. Some of the diaries were found at Terezín, a "model" ghetto designed to reassure international organizations like the Red Cross that the Nazis were treating deportees well. Actually, Terezín was only an interim stop before the extermination camps at Auschwitz-Birkenau and Minsk.

In the words of Yitzhak Katzenelson,* poet and Holocaust victim who died in Auschwitz in 1944:

> The first to perish were the children,
> abandoned orphans,
> The world's best, the bleak earth's brightest.
> These children from the orphanages might have
> been our comfort.
> From these sad, mute, bleak faces our new
> dawn might have risen.

The diaries, poems, and photographs printed here suggest an ephemeral vision of what the world lost with the children who perished in the Holocaust.

OPPOSITE ▶

This photograph was sent to Dr. Sybil Milton, Historian U.S. Holocaust Memorial Council, with a letter: "Dear Dr. Milton, I read that there will be a Children's Holocaust Memorial Center in Washington, D.C. I am sending you a picture of my brothers in blessed memory. They were born in Pabianice, Poland. They were killed in Auschwitz. Their names are: Zewel-Laizer Koplowicz, born in 1928, and Abrachman Koplowicz, born in 1934. The oldest and tallest in the picture is me — Zelda Koplowicz Klaiman. I am the only witness to give testimony. If possible, please have their pictures in the children's museum. They belong there. Thank you, their sister. Zelda Klaiman" Courtesy of U.S. Holocaust Memorial Museum, Washington, D.C.

Miriam Sondheimer and her family were deported in 1940, when she was 18, from Heidelberg to the concentration camp of Gurs in Southern France. The family was later able to migrate to the Dominican Republic and after the war to the United States. Miriam Sondheimer Gerber now lives in New York.

. . . We are still in bed. It is 7:30. Suddenly I hear unfamiliar men's voices in our foyer, and then I understand what they are reading. "You have an hour to be at the train station. Each person is allowed 50 kg. of luggage. Food for four days." Then various directives about things that we are not allowed to bring. . . . Only wedding rings, watches and utensils (may be taken). . . . A police officer stands by the door. He does not let anyone in or out. Our packing is topsy-turvy . . . We are the last (of the Jews being deported) to be picked up. . . . The house keys are turned over. . . . Many people walk by, stand nearby or look out their windows. All gawk, many laugh, some are grave. We are calm and proud. . . .

We . . . are received (at the train station) by the police and the SS. In a room Papa signed a testament that the Reich is his trustee, or something to that effect. . . . We board (the train) and get a D-class compartment with SS dogs. It is midnight. . . .

From *Jewish Life in Germany, 1789-1949*, edited by Monika Richarz. Bloomington: Indiana University Press, 1991. Publication of the Leo Baeck Institute, New York. Translation by Sidney and Stella Rosenfeld.

Charlotte Veresova, of Prague, kept a diary while in the ghetto of Terezín in Czechoslovakia when she was 14 years of age. Although Terezín was a "model" ghetto, conditions were far from ideal, and most of its inmates eventually were deported to Auschwitz.

Everything here is so strange — different from anywhere else in the world . . . We sleep in bunks and everywhere lots of people are packed in. Husbands and wives do not live together and their children live separate from them in homes, or whatever you call it. When you hear the word "home" you imagine something quite nice. Well, it's all quite different, because that is how it must be. Nevertheless, I envy the others a little, because they can at least visit their parents. I am here completely alone — without mommy and dad and without my big brother whom I miss so much.

I was fourteen years old not long ago and I had never been away from home before, not even over the holidays, because I have no grandmother or aunt whom I could have gone to visit. So this is my first trip away from my parents and it's so strange. I should be glad that my folks are not here, and actually it's better that way. They will send me parcels and that's fine and dandy, and soon the war will be over and I'll go home. Every one said that I'm going for only a couple of months and perhaps I can hold out that long.

My father is Jewish and my mommy is Aryan, so my brother and I are mixed, and children of mixed marriages must, according to some German laws, go to Terezín. Why, I don't know, nor why it has to be us and not Dad, it's all a big mix-up. They say Mom saves Dad from being sent in a transport, but not us. It isn't clear to me, so I sit here in my bunk and write and am unhappy. . . .

The food here stinks. I wonder that anyone can eat it . . . We manage to get only one kilogram of bread every three days. They bring it in old hearses pulled by people. They also carry corpses in them. Sometimes we get mouldy bread . . . We cut off the mouldy part and then we must slice the rest in very

*Yitzhak Katzenelson's poem appears in *Song of the Murdered Jewish People*. Israel: Hameuchad Publishing House, Ltd. Beit Lohamei Haghetaot (Ghetto Fighters' House), 1948 and 1969.

Ilse and Barbara Ledermann on the Nerwe de Plein in Amsterdam on February 13, 1934. The Ledermann family moved to the Netherlands from Germany in 1933, the same year as the Frank family. Barbara Ledermann was friends with Anne and Margot Frank. Courtesy of Barbara Rodbell Collection, U.S. Holocaust Memorial Museum, Washington, D.C.

thin slices to make it stretch . . . If only we get enough. Sometimes I'd cut off another slice, but I mustn't. I'd just gobble it all down and then the third day I wouldn't have any. Now I've begun to think too much about food . . .

I've learned here to appreciate ordinary things that, if we had them when we were still free, we didn't notice at all. Like riding in a bus or a train, or walking freely along the road, to the water, say. Or to go buy ice cream. Such an ordinary thing and it is out of our reach.

Sometimes when I stand on the bastions and below me there is mud and swamp — jumping down would probably mean death. Sometimes it strikes me — would I jump if that would bring the end of the war? I should like to give my life so that it would. I should like to perform some great deed, so that my name would not die out, but I'll not be able to do anything. I know it is stupid. . . .

It is rumored that they are building gas chambers here. People whisper about it and they really are building something mysterious in the fortification catacombs with airtight doors. They say a duck farm. What for? Might it be gas? I can't believe it. It is too terrible. Never before have I truly admitted the idea of death, and now gas all of a sudden. It's terrible, even if the longed-for end of the war is coming closer. Oh, how stupid I was when I was unhappy over silly little things! For example, that I was unlucky in love, or that I didn't want to get up in the morning. Everything is so petty compared to this thing. Here it is a question of life and we have only one single life. No, it mustn't happen, they can't do it, no one will let them! But why shouldn't they do it? Who prevented them from bringing us here and who will prevent the gas chambers, who — God?

From *Terezín*. Prague: Council of Jewish Communities in the Czech Lands, 1965.

Teen-ager Helga Weissova-Hoskova wrote in her diary of events in Terezín. The transports to which she refers consisted of Jews being deported to Auschwitz for almost certain death by gas.

Typhoid has raged throughout Terezín. The hospitals and infirmaries are crowded. They have cleared out a whole house and made a typhoid ward of it. Everywhere you see the sign "Achtung, Tyfus [Attention, Typhus]." At every water faucet and pump, "Don't forget to wash your hands" — but, anyway, the water hardly ever runs. And a transport again . . . they say it didn't go to Poland, that the front lines are there already and the transport went to some new camp on the Polish border. . . . It probably is the same everywhere. . . .

Old people's transport. Ten thousand sick, crippled, dying, all of them over 65 years old. It's horrible everywhere. I am too exhausted to stand the

In addition to serving as president of the Jewish community of Berlin during the Nazi period, prominent insurance executive Heinrich Stahl played a vital role in the creation of the Jewish Winterhilfe, an organization that provided a broad range of vital basic services such as food, health care, and shelter to Berlin Jews. Stahl was also instrumental in the formation of social organizations for German Jews in the mid-1930s following their exclusion from traditional German associations. This social network greatly benefitted Jewish children, promoting cultural endeavors such as youth orchestras and providing toys. Courtesy of Leo Baeck Institute, New York, Heinrich Stahl Collection.

sight of misery and suffering again. The old people's transport, the young people cannot volunteer. Children have to let their old parents go off and can't help them. Why do they want to send these defenseless people away? If they want to get rid of us young people, I can understand that, maybe they are afraid of us, don't want us to give birth to any more Jewish children. But how can these old people be dangerous? If they had to come here to Terezín, isn't that enough, can't they let them die in peace here? . . .

Under the window the Gestapo are shouting and beating people, closing the street. Another group is going. There they are, carrying stretchers, two-wheeled carts with corpses, baggage and the "corpse cart." The street that had blossomed in the August heat was wrapped in heavy, filthy dust. Baggage, stretchers, corpses. That's the way it's been going on for a week. The dead on two-wheeled carts and the living in hearses. Everything is transported in hearses here: dirty linen, bread. . . . among the baggage, is that corpses? No, one is moving, through the cloud of dust whirling around the cart a yellow armband shines through. Who could forget that! We met them daily in the kitchen, on crutches, blind, with a little bowl in hand, begging a little coffee, soup, scraping out the unwashed troughs and kettles that had food, or else raking through piles of rotting potatoes, peelings and garbage. Yes, that's who it is, skinny, hungry, miserable, there they are, alive in hearses. How many of them will arrive at their destination, how many will return? All the hearses are in operation. For the first time they have a load of the living, and yet this is more fitting than anything else. Where will these human wrecks land, where will their bodies be laid down? No one will weep over them, no one pities them. Some day perhaps there will be a mention of them in readers, and then the only title that would do them justice would be: Buried alive. . . .

From *Terezín*. Prague: Council of Jewish Communities in the Czech Lands, 1965.

As an adult, Nelly Toll wrote of her experiences of the Holocaust. She was a small child when the German Army occupied the Lithuanian city of Lwow in 1941, and she and her family were soon sent to the ghetto. In 1943, Nelly and her mother were given refuge by Christian friends of her father's, Mr. and Mrs. Z, who built for them a hiding place with a small curtained window.

One day, as we sat in the kitchen with Mrs. Z., the doorbell rang. We ran to our room. Mrs. Z. quickly turned the key, and the room was locked. Only then did she open the front door. But my mother had dropped a ball of wool on the kitchen floor and had forgotten to let go of the end. Although we heard a neighbor's voice in the kitchen, my mother, without thinking, continued to pull on the red wool. The ball began to roll over the kitchen floor toward our door. At that instant, I ripped the strand in two. In the kitchen, on the other side of the door, Mrs. Z. picked up the ball, and the wool disappeared underneath the door. Our lives were suspended in that small crack of space that separated the wooden floor from the bottom of the door. Luck was with us. . . .

Standing behind the curtained window, I watched the children playing and wished that I too could go outside.

. . . Small green leaves covered the trees and sunshine splashed the streets. Spring was getting Lwow, casting warm shadows on crowded P. Square. Little girls' boots were replaced by shoes, scarves were discarded, jackets were opened. The children's laughter matched the weather. A balloon floated past our window and almost touched the bricks . . .

I watched the world outside intently, always hoping to see my father suddenly emerge from the crowd, waling briskly toward our building, his hat pulled low over his eyes. My father had visited us twice before. He had stayed only a short time, promising to return when he was sure that the rest of the family had found a safe hiding place. . . .

But I never saw my father again.

From *Without Surrender: Art of the Holocaust*, by Nelly Toll. Philadelphia: Running Press, 1978.

Alice Lok Cahana, now an American artist, was 15 in 1944, when she was taken with her family from their home in Sarvar, Hungary by the Nazis. She spent the next 1½ years in Auschwitz and other camps. This poem was written shortly after liberation while Alice was recuperating in Sweden.

THE SHADOWS AT NIGHT
The Shadows in the dark question me
Are you defeated?
I answer — No! not me!
Then you must be made, child!
Don't you see the long line . . .
Children, grown-ups, in the endless night
The fire around them engulfs their faces:
But they still whisper prayers.

And you who got life instead
What will you do with the memories of that long night
Will you listen to casual chatter,
Or will you scream, that does not matter!!
The people . . . the people in the line,
Their eyes and faces; they pray for help
They pray for forgiveness
Of sins they never committed!
They hoped for an answer, they hoped for help
And their eyes pierced through the iron gates
Their hands reached to heaven with request:
Where are our brothers
The strong free men?

But the silence was
Choking and bold
And the rain brought
The unexpected cold
The flames killed the soul of all men
Silence was the answer of the free man.
The shadows at night talk to me.
Why are you not mad?
They question me . . .

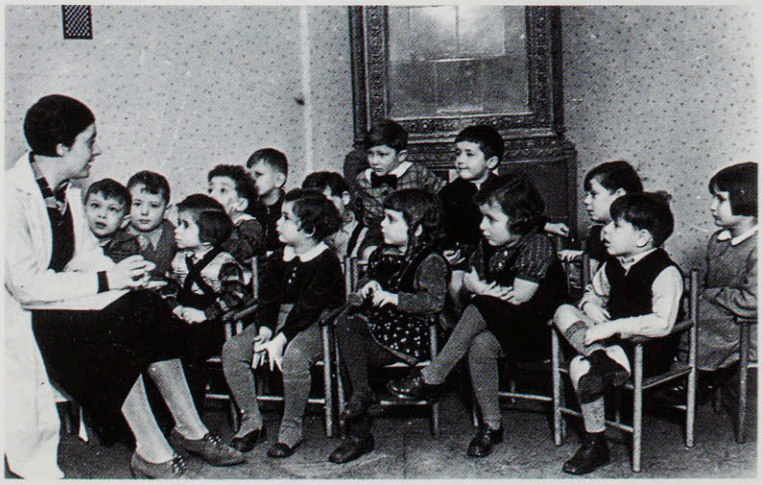
From *Ashes to the Rainbow: A Tribute to Raoul Wallenberg, Works by Alice Lok Cahana*. Los Angeles: Hebrew Union College Skirball Museum, 1986.

BELOW TOP

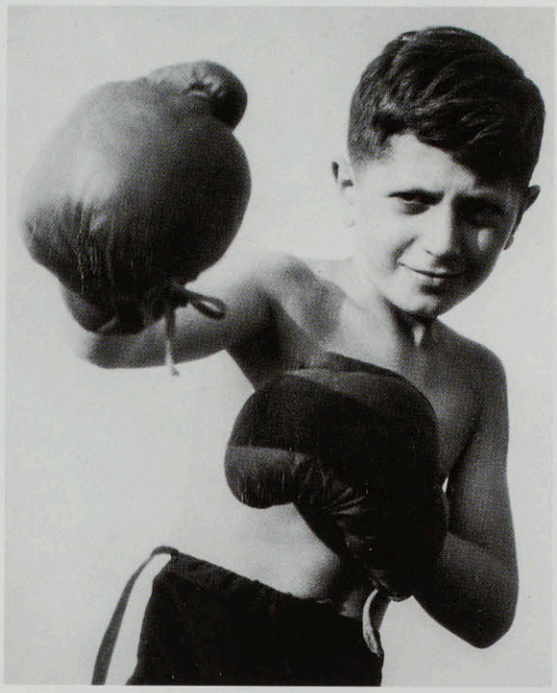
Gypsy children playing in front of the armory on Unter den Linden in Berlin. This photograph was taken by Friedrich Seidenstücker in 1931. Courtesy Bildarchiv Preussicher Kulturbesitz, Berlin.

BELOW BOTTOM

Storytelling hour at the kindergarten of the Jewish Community, Berlin, 1934. Photographed by Abraham Pisarek. Courtesy of Dr. Ruth Gross-Abraham Pisarek Collection, U.S. Holocaust Memorial Museum.



In this 1938 photograph, Menachem Borenstein, son of Avraham and Szaidal Borenstein, mounts his bicycle in the town of Szvider, Poland. Menachem loved the study of science and anatomy, and dreamed of becoming a physician. His father was a rabbi. His mother was deported from the Warsaw Ghetto to Treblinka on July 22, 1942, where she died. A few years later, Menachem escaped from the ghetto and went into hiding with Sylvia Kolski and her father in Krushev, Poland, on the farm of a family named Pavlach. Menachem Borenstein died of an unspecified illness shortly before liberation. Courtesy of U.S. Holocaust Memorial Museum. Donated by Abraham and Sylvia Kolski in memory of their parents Matys and Dobrys Kolski and Frymet Kramarska and Mendel Kramarski.



A young boxer, a member of the Makkabi sports club in Berlin, shows his jabbing form. The founder of the club was Heinrich Stahl. Stahl was deported to Terezín in 1942. Courtesy of Leo Baeck Institute, New York, Heinrich Stahl Collection.

Miroslav Košek was born on March 30, 1932, at Horelice in Bohemia and deported to Terezín on February 15, 1942. He died on October 19, 1944 at Auschwitz.

IT ALL DEPENDS
ON HOW YOU LOOK AT IT
I.
Terezín is full of beauty.
It's in your eyes now clear
And through the street the tramp
Of many marching feet I hear.

In the ghetto at Terezín,
It looks that way to me,
Is a square kilometer of earth
Cut off from the world that's free.

II.
Death, after all, claims everyone,
You find it everywhere.
It catches up with even those
Who wear their noses in the air.

The whole, wide world is ruled
With a certain justice, so
That helps perhaps to sweeten
The poor man's pain and woe.
Miroslav Košek

From *I Never Saw Another Butterfly . . . Children's Drawings and Poems from Terezín Concentration Camp 1942-1944*. New York: Schocken Books, 1978. Reprinted courtesy of the State Jewish Museum, Prague.

František Bass was born in Brno on September 4, 1930, deported to Terezín on December 2, 1942, and died in Auschwitz on October 28, 1944.

THE GARDEN
A little garden,
Fragrant and full of roses.
The path is narrow
And a little boy walks along it.

A little boy, a sweet boy,
Like that growing blossom.
When the blossom comes to bloom,
The little boy will be no more.
Franta Bass

From *I Never Saw Another Butterfly . . . Children's Drawings and Poems from Terezín Concentration Camp 1942-1944*. New York: Schocken Books, 1978. Reprinted courtesy of the State Jewish Museum, Prague.

After declining an offer of refuge in Palestine, Friedl Dicker-Brandeis was deported to Terezín in 1942; while there she taught drawing to children inmates. She was sent to Auschwitz in October 1944 and later died at Birkenau.

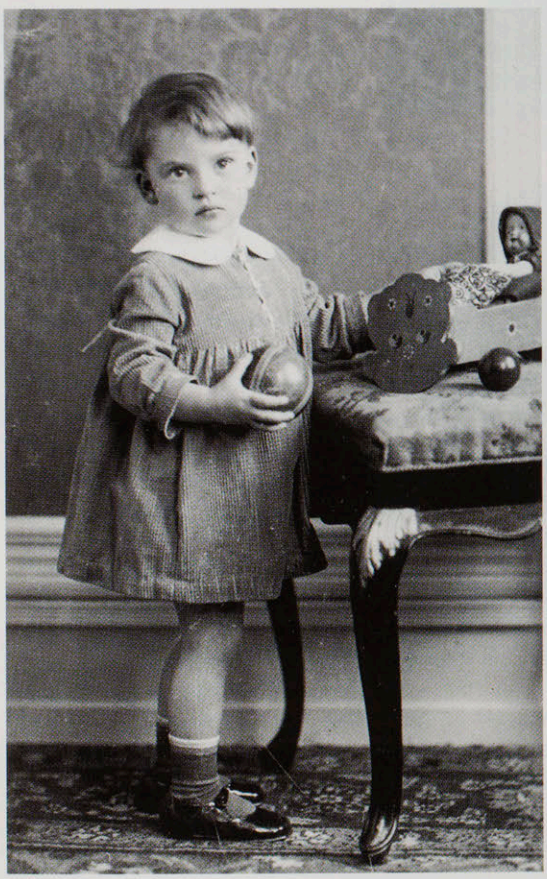
Evicka, one of Frau Brandeis's pupils at Terezín, wrote the following, untitled poem when she was 9 years of age. She had been deported with her parents but separated from her grandmother in the process; none of the four survived.

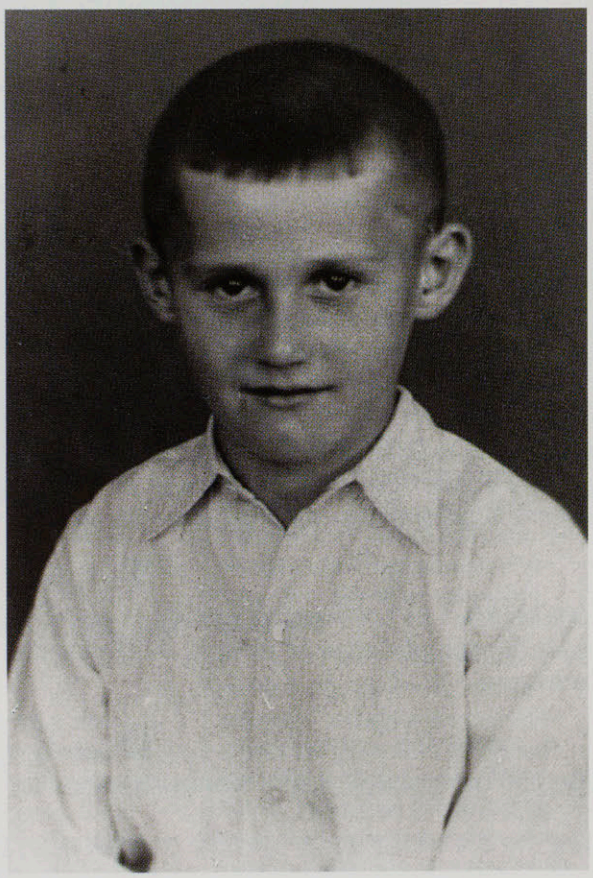
Sunny, red bug,
Sit on my palm for a while.
You're flying outside,
From roses to trees.
In the evening you come
back home!
Buggie! Darling!
Fly away from the Ghetto.
There is no sun here.
There is no warmth here,
There are no bushes here,
There are no roses here,
Everyone suffers,
Longing to return home.
Where will you settle, Buggie?
Where will you fly, sunny?
When will my granny come back
From the east?
Evicka

From *From Bauhaus to Terezín: Friedl Dicker-Brandeis and Her Pupils* by Elena Makarova. Jerusalem: Yad Vashem, The Holocaust Martyrs' and Heroes' Rememberance Authority, The Art Museum, 1990.

Edited by Ann Seaman from diaries, poems, and photographs compiled by Stephen Goodell, Alvin Rosenfeld, Sybil Milton, and Derek Symer of the U.S. Memorial Holocaust Council, Washington, D.C.

Gypsy children at play near the town of Unna, just east of Dortmund in Westphalia, Germany. The children were photographed by Friedrich Seidenstücker in 1930. Courtesy of Bildarchiv Preussicher Kulturbesitz, Berlin.





LEFT

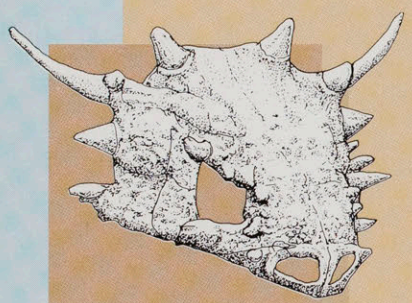
Renate Picard, age 2 or 3, 1928, Cologne. Her father, Jacob Picard, was a lawyer, author and poet from Cologne. He emigrated to the United States in 1940 via the U.S.S.R., Manchuria, Korea, and Japan, and returned to Germany in 1958. Renate survived the Holocaust and lived in Holland after the war. Courtesy of Leo Baeck Institute, New York, Jacob Picard Collection.

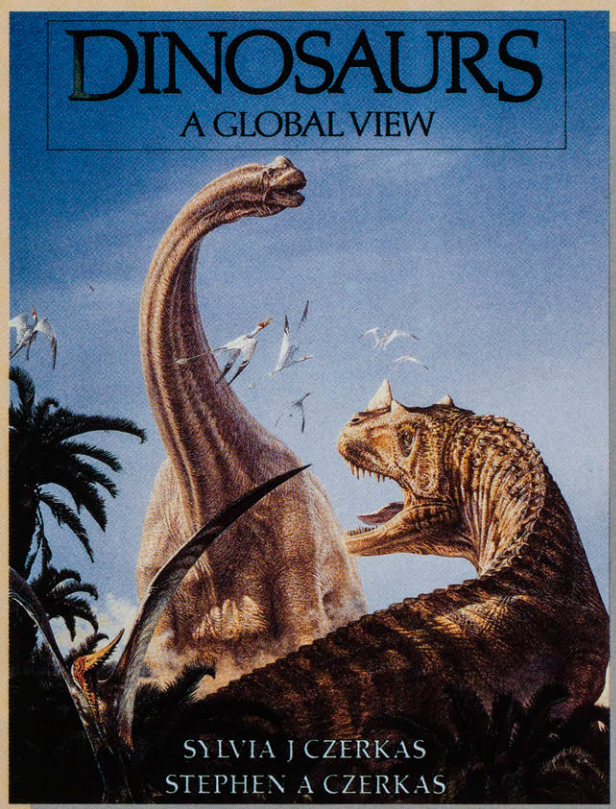
RIGHT

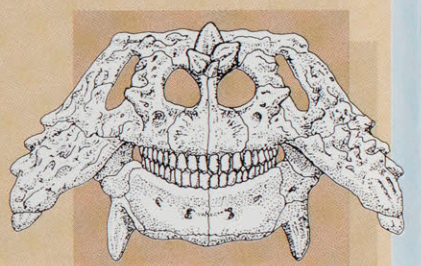
Pre-war photograph of Fred Goldschmidt, who was born on May 10, 1928 in the small Hessen town of Sprendlingen, near Frankfurt. His family had lived there for six generations. His father, the kosher butcher and slaughterer for the Orthodox Jewish community, lost his livelihood following the violence of Kristallnacht (the organized nation-wide pogroms of 1938). Fred Goldschmidt and his family immigrated to the United States by way of Italy in March 1940. Courtesy of Museum of Jewish Heritage, New York.

DINOSAURS
A GLOBAL VIEW

A catalog to the exhibit on view at the Natural History Museum of Los Angeles County







8 JUNE THROUGH 25 AUGUST 1991

Utilizing the most up-to-date scientific research, authors Sylvia and Stephen Czerkas provide a remarkable new book that explores the mysterious world of the dinosaurs. *Dinosaurs — A Global View* presents a clear and exciting chronology documenting the worldwide events that led to the origins, continual evolution and extinction of the dinosaurs.

Lavishly illustrated with over 90 beautiful color plates, the prehistoric past is brought to life in stunning images complemented by 27 maps and over 90 skeletal drawings. In a highly detailed account based on tangible evidence from fossil records, this comprehensive overview confronts many popular myths and controversial misconceptions about dinosaurs.

The authors have dedicated this book to the staff of the Natural History Museum of Los Angeles County, especially the Director, Craig Black, and to museums throughout the world for the education of today's children and the preservation of our planet's history for the children of tomorrow.

Dinosaurs — A Global View, by Sylvia and Stephen Czerkas. 247 pages, 90 color plates, index, bibliog. Hard cover. $39.95.

ORDER YOUR COPY FROM THE MUSEUM BOOKSTORE

The Museum Bookstore, located at the North Entrance of the museum, stocks a wide selection of books about prehistoric life. For further information, or to order *Dinosaurs — A Global View* by telephone, call (213) 744-3434.

Book Reviews

THE EARTH CARE ANNUAL 1991 edited by Russell Wild, Rodale Press, Inc. Hardbound, 236 pages, $17.95.

THE ENVIRONMENTAL MOVEMENT has made great strides in the past twenty years in increasing public awareness of ecological problems facing our planet. Mainstream news magazines, dailies, and radio and television no longer treat environmental subjects as specialized human interest asides. Sadly, this "consciousness-raising" has rarely translated to concrete action reversing environmental degradation. Marginal successes in recycling and pesticide reduction, for example, have failed to balance our society's other excesses of poisoning and plundering the land. A premium exists, therefore, on eco-publications that go beyond statements of the desperation of our plight and suggest concrete plans of action. *The Earth Care Annual 1991* is such a work.

The *Annual* is a compilation of articles from sources such as *Time* Magazine, the *New York Times*, and the *Christian Science Monitor*, with an emphasis on citizen and environmental group action. The doomsaying is balanced with actions that can be implemented by everybody. The 56 articles are grouped into such categories as "Garbage," "Greenhouse Effect," "Oceans," "Pesticides," "Tropical Forests," and "Wildlife." The book concludes with an "Environmental Shopper's Guide" and a directory of environmental groups.

The treatment of subjects is, of necessity, uneven. The section on wildlife, for example, deals with the "sexiest" issues — dolphins, elephants, and whooping cranes. The more subtle but far more important large-scale loss of biodiversity through habitat destruction or modification is only hinted at. But in all, the selection of articles provides an excellent overview of how citizens and watchdog groups have identified and solved, or at least mitigated, environmental problems. Scattered through the book are highlighted boxes entitled "What You Can Do." Most of these are common-sense routines that will not be new to someone enlightened enough to read this book in the first place. The challenge is to educate others who might not think to peruse a book like this!

The enormity of our environmental problems, and the reluctance or inability of governments to adequately deal with such problems, make the actions suggested in this volume seem little more than tiny band-aids on a massively hemorrhaging patient. But if any hope exists, it has to start with action on the part of concerned individuals — personal deeds that may help restructure policy at the highest levels.

KIMBALL L. GARRETT
Collections Manager
Section of Ornithology

INTERNATIONAL WILDLIFE TRADE: WHOSE BUSINESS IS IT? By Sarah Fitzgerald, World Wildlife Fund, 1989. Paper, 459 pages, $25.

AS WE ARE ALL AWARE, THE world's wildlife populations are in crisis: numbers are declining and habitat is disappearing. Sarah Fitzgerald's book is an excellent compendium of information on one major cause of depletion, namely international trade in wildlife species.

International trade in endangered species is regulated under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), an international treaty signed in 1973 by 89 countries, including the United States (by 1989, when this book was published, there were 99 signatories to the treaty). Problems still abound, however, with some signatory nations turning a blind eye to trade in endangered species, with non-signatory nations acting as conduits for trade, and with tremendous enforcement problems facing all nations, most especially those with other pressing problems related to human population growth. Ms. Fitzgerald discusses all of these concerns and outlines in some detail how the treaty works. She also provides a list of all species that were covered by CITES as of October 22, 1987 (this list is revised on a regular basis).

The book is an extraordinary source of information on population status of species, major threats to species, trade routes, volume of trade, and consumption of endangered species. The research that went into the volume is prodigious, with sources ranging from scientific literature to governmental reports to consultations with numerous experts. Particularly enlightening is a table listing imports into the United States for a typical year; the US imports more species and more individuals (endangered and otherwise) than any other country in the world.

The bulk of the book is taken up with chapters on various groups of endangered organisms, giving details on their status and the trade in those species. For example, the chapter on parrots begins with a description of their variety and distribution, followed by a discussion of the hazards of trade to the group: studies have demonstrated that 40 per cent of parrots die during shipping and quarantine. Trade has been a major cause of decline in the wild of a number of species now under the protection of CITES (which now covers all but three species), including the hyacinth macaw and the military macaw. (An estimated 150,000 birds were smuggled into the United States from Mexico in 1985, most of them parrots. The United States imported 312,000 parrots in 1985.) Trade volume, trade routes, and illegal trade in parrots are described — something to keep in mind the next time you consider buying that pretty cockatoo at the pet shop in the mall! A section with recommendations to potential parrot owners is provided.

Commendably, the book includes plants, invertebrates, and small vertebrates as well as the "charismatic megavertebrates" such as pandas, condors, and elephants, which garner most of the public's attention. Those lesser-known species are facing the same threats and are just as worthy of consideration. A list of additional readings and a complete bibliography are provided for the reader who wishes to pursue a particular topic.

One may wonder why someone not working directly with endangered species should be interested in purchasing this book. Ms. Fitzgerald provides a chapter entitled, "What Can Be Done: The Importance of Citizen Action," a general chapter augmented by more detailed recommendations in the taxonomic chapters. She points out the importance of consumers understanding the issues involved in wildlife trade. This book provides the necessary information for such understanding, and her recommendations give us all the opportunity to contribute to the war against international trade in endangered species.

SARAH B. GEORGE
Associate Curator
Section of Mammalogy

Southland Diorama

The Unarmored Threespine Stickleback

In 1917, the unarmored threespine stickleback, a small, scaleless fish, was reported to be abundant in the Los Angeles, San Gabriel and Santa Ana River systems of the Los Angeles basin. At that time, the conditions necessary for its survival — barrier-created pools in which to breed, shoreline vegetation for protection, stream flow for nesting, and river bed vegetation that supported the aquatic organisms eaten by the stickleback — were abundant. Today, those rivers have been reduced for the most part to concrete-lined drains, and the last self-sustaining populations of unarmored threespine sticklebacks are confined to the Soledad Canyon section of the Santa Clara River and a few of its small tributaries.

The unarmored threespine stickleback is a subspecies of the threespine stickleback (*Gasterosteus* ["belly bone"] *aculeatus* ["spine"]), an inconspicuous fish with a compressed, spindle-shaped body covered with a few bony plates or shields in place of scales. This species is found throughout the northern hemisphere south to northern Baja California, and in north Africa. Three subspecies — including the unarmored threespine — are recognized in California. In addition, distinctive populations of stickleback are known from Baldwin Lake in the San Bernardino Mountains and in San Antonio Creek on Vandenberg Air Force Base.

The unarmored threespine usually has no plates, but it may sometimes have two or three anterior ones along its sides. Some biologists believe that it lacks protective armor because predatory fishes are scarce in the upper reaches of the river systems where it has made its home. And indeed, the three morphologically defined subspecies of stickleback in California are distinguished from each other by a progressive reduction of bony armor in more southerly populations, particularly the number of lateral plates. These plates help support the fish's pelvic spines, low on its belly. When the fish is attacked, the stiff spines flip out almost perpendicular to its body and lock into place, making it difficult to eat. In predation experiments with all the stickleback subspecies, those with fewer plates are eaten more readily than ones with more armor.

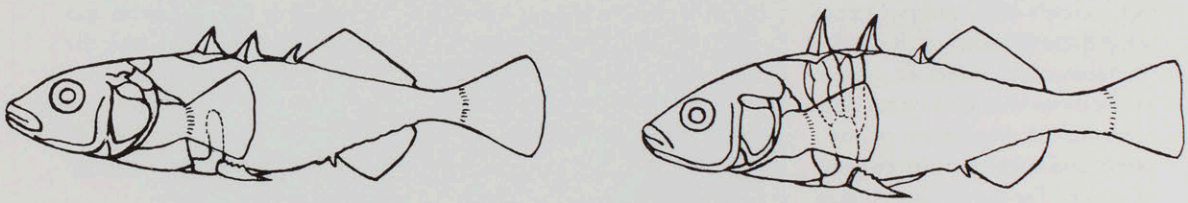
In spring, the male stakes out a territory from which he excludes other sticklebacks, changes from his normal drab greenish-brown and silver to beautiful overall pale blue — with the throat and belly a brilliant red and the eyes iridescent blue — and builds a small mounded nest of decayed strands of plant material held together by a special substance secreted from the kidney. He locates the nest in slightly flowing but not stagnant water near submerged plants; when he moves through it, making a cavity where the eggs will be deposited by a female, the nest is completed. The male leads a female with ripe eggs to his nest, where she deposits her eggs and he fertilizes them. One nest may contain the eggs of more than one female, and one female may spawn several times from the late spring to early fall.

The male protects the nest from hungry predators and insures an adequate water flow over the eggs by alternately fanning and repairing the nest; a slow flow of clean water is needed for the eggs to develop properly. Over the next few days, while the eggs incubate, he chases intruders out of his territory. The eggs hatch after about six days, and the fry leave the nest after a short period of time. A male raises several broods in a reproductive season, which is concentrated in spring and early summer.

Mature individuals may grow to about four inches in length, but a three-inch one would be considered large. Their food consists of small aquatic insects and crustaceans, along with algae.

The unarmored threespine stickleback is named *Gasterosteus aculeatus williamsoni* after Lt. R.S. Williamson, who first collected it in the mid-1800s while doing government surveying for a western railroad route. When discovered, it had been an inhabitant of the Los Angeles basin for up to 30,000 years: it is one of the three species of freshwater fishes recovered from the Pleistocene terrestrial deposits at Rancho La Brea. The unarmored threespine and six other species of fish have inhabited the inland freshwaters of southern California into historical time, but within the last 45 years the stickleback has become an endangered species and is now protected from capture by law.

Because sticklebacks were once so common in southern California waters, they were not often collected by scientists studying freshwater fishes. In fact, it is only in the last 20 to 30 years that the museum's ichthyologists have focused attention on local popu-



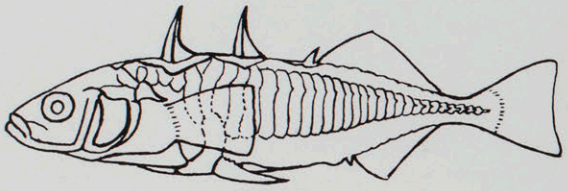
Unarmored

Partially Armored

The three subspecies of stickleback in California are defined by differences in the number of bony plates along the sides of the body.

lations of freshwater fishes in general; we now monitor abundance of these populations and carefully preserve specimens in our reference collections for future studies. We have a small collection of sticklebacks that includes a unique sample, a few unarmored threespines taken from the Los Angeles River in the 1930s. As we have turned attention to freshwater fishes, the Natural History Museum has become a clearing house for information on southern California's native species.

Sticklebacks cannot survive in concrete-lined channels. We recently completed a study of sticklebacks for the California Department of Fish and Game; our final report to the department included an assessment of the status of local populations and recommendations on habitats and localities that must be preserved if our populations of these fish species are to survive in the wild. Unarmored three-



Armored

spines were introduced into San Felipe Creek in San Diego County a few years ago by the California Department of Fish and Game. The recovery plan prepared by the U.S. Fish and Wildlife Service for the stickleback includes reintroducing it to other suitable habitats in the Los Angeles basin — when and if they return to a viable status.

Camm Swift
Associate Curator
Section of Ichthyology

JOE NAKANISHI

The three-spined stickleback, *Gasterosteus aculeatus*, one of three species of fish found at Rancho La Brea.

Southland Diorama *is a TERRA column that highlights the diversity of animal and plant life still to be found in southern California. Each issue features an example of one of the many species — extant and extinct, native and introduced, abundant and endangered — that are found in astonishing variety in one of the world's largest urban centers.*

Focus on the West

The Photographs of Viroque Baker

THIS IS A 1930S NORTHWARD VIEW of Olvera Street. The left side of the photograph shows part of the historic Avila Adobe, built around 1818 and still standing. The three women on the right are sitting on the balcony of the 1887 Sepulveda House which, in the 1930s, was filled with small shops and studios and a restaurant that served food on the balcony. These women, however, are concentrating on something other than food. Notice that one of them appears to be reading the palm of another, while the third woman observes.

The photographer, Viroque Baker, did not have to travel far to capture this image. She and another photographer shared a studio in the Sepulveda House. Baker was a Montana native who came to California with her photographer mother in 1903, and had a studio on Olvera Street from 1930 to 1937. She studied at the Clarence White Photography School in New York before opening her studio in Los Angeles.

Baker, like many fine art photographers, often used platinum prints in her work. Photographers began making platinum prints around 1880, but from the start the technique was used primarily by fine art photographers. This was due to the high cost of the technique as well as to the look it produced. Notice that this is a soft, low-contrast image. Additionally, the uncoated paper used as the support allowed the photographer to alter an image by using pencil, charcoal, or watercolor. Baker (or somebody else) modified this photograph. Look, for instance, at the clean lines on the shoulders of the woman closest to the camera, or at the more obvious alterations made to the people walking down the center of Olvera Street. Although the paper support is susceptible to deterioration over time, the image on a platinum print is remarkably stable. The Seaver Center has over two hundred original Viroque Baker prints in its collection.

JANET EVANDER
Senior Collections Manager
Seaver Center

Focus on the West *is a* TERRA *feature that presents the photographic highlights of the museum's Seaver Center for Western History Research. The Seaver Center is rich in photographs and other materials relating to the history of the American West.*

VIROQUE BAKER COLLECTION, P.57, # 12

House Calls

Q: I've just inherited my great-great grandfather's leather chest. How should I care for it?

A: Some of the worst things that happen to objects are the result of well-meaning but uninformed care. A leather chest can be harmed by bright light, changing temperature and humidity, and bugs. If you have recently brought the chest from a very humid climate, try to keep it in the coolest part of your home for several months. The leather and wood will crack if they dry too rapidly. For the same reason, do not keep your chest near a heating or air conditioning duct. Avoid placing it where direct sunlight or bright light will fall on it. Light not only fades colors, but will actually begin or accelerate the chemical processes of degradation.

Inspect your chest thoroughly for signs of frass, the technical term for insect leavings. Look for powdery material or tiny pellets, wings and carcasses. If you find frass, remove it; old frass may remain from a previous pest attack and will mask signs of fresh infestation — as well as being attractive to other pests. Conservators use a soft brush to whisk dust and frass into the nozzle of a vacuum cleaner set on low; it is not advisable to apply the nozzle directly to the surface of a delicate piece. Check the chest periodically for fresh frass, an indication of active pests. If there is an active infestation, it is important to have the trunk fumigated. Local museums and collectors can help you find a reliable fumigator.

Resist the temptation to "feed" the leather by rubbing oil into it. Most leather has already been over-lubricated by previous caretakers, and although it is gratifying to rub leather dressing into an old piece, too much oil can weaken the hydrogen bonds that hold the leather together. Most leather does not require anything other than occasional dusting. Old spots and stains will resist all efforts to remove them and water can permanently damage leather. If the trunk has significant monetary or sentimental value, it would be advisable to consult a conservator before attempting any cleaning or repair of the leather, wood structure, or metal hardware.

Sharon Blank
Conservator
History Division

The museum's staff members are often asked to answer historical questions, or to identify artifacts and specimens that people have found, purchased, or inherited. House-calls *is a feature of TERRA in which curatorial experts discuss interesting questions frequently asked them by Museum Members and the general public.*

Leatherbound trunk from the U.S., circa 1850, showing typical wear; metal bands underneath the leather are showing through at the base.

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YOUR VIEW TO THE WORLD

MUSEUM TRAVEL PROGRAM, 1991

MICRONESIA
June 22-July 6, 1991
Explore these enchanting islands of the north Pacific, from the Marshalls to Palau. Visit local artisans and explore the marine environments of Hawaii, Pohnpei, Nan Madol, Truk Lagoon, Fefan Island and Yap on this cultural and natural history tour.
$3,390 plus air fare of $1,743.

QUEEN CHARLOTTE ISLANDS
June 30-July 7, 1991
The Queen Charlotte Islands are considered one of the richest biological and cultural areas of North America. Aboard the 68-foot sailboat "Island Roamer," see abandoned Haida Indian villages and an abundance of wildlife, including killer whales, Dall's porpoise, Bald Eagles, puffins, black bear, and river otter.
$1,740 plus air fare.

ECUADOR: ANDES, AMAZON AND GALAPAGOS
July 18-August 3, 1991
Travel by foot and dugout canoe through the virgin tropical rainforest at La Selva. Shop in Quito and at the Saquisili Indian Market. See Cotopaxi National Park, and the world's highest active volcano. Cruise through the Galapagos Islands aboard the 20-passenger "Galapagos Adventure."
$4,708 including air fare.

AMERICAN SOUTHWEST: ANCIENT ANASAZI
August 18-27, 1991
Study the history and culture of the Anasazi as you explore Bandelier National Monument, Chaco Canyon, Aztec Ruins, Mesa Verde, magnificent Canyon de Chelly, the Hopi Mesas, Monument Valley, and the Grand Canyon. Meet the people who live much as their ancestors did, surrounded by the natural beauty of the American Southwest.
$2,190 plus air fare.

CHESAPEAKE BAY: ECOLOGY AND HISTORY
October 19-26, 1991
The Chesapeake Bay is a maritime highway rich in history and contrasting ways of life, and it typifies the interplay of our nation's cultural, political and natural history. One of the most complete estuarine systems in the world, its rich waters are fringed by marshlands and mud flats, home to osprey, egrets, herons and ducks. See it all from the 100-passenger "Nantucket Clipper."
From $1,600 plus air fare.

GUATEMALA: HEARTLAND OF THE ANCIENT MAYA
December 7-22, 1991
Climb the spectacular Mayan temples at Tikal, deep in the rainforest, and explore the fascinating hieroglyphic stairway at Copán, Honduras. Bargain for incomparable textiles in Chichicastenango's bustling market. Rest beside the peaceful waters of Lake Atitlán, and walk the cobbled streets of colonial Antigua.
$2,566 plus air fare of $584.

ANTARCTICA
January 6-20, 1992
Retrace the routes of polar explorers and discover the world's last unspoiled wilderness aboard the "Society Explorer." Visit rookeries of chinstrap, macaroni and Adélie penguins and watch bellowing seals close at hand during Antarctica's austral summer.
From $5,950 plus air fare.

ANTARCTICA

For further information, please contact:

Karen Hovanitz
Museum Travel Program
Natural History Museum
900 Exposition Boulevard
Los Angeles, CA 90007
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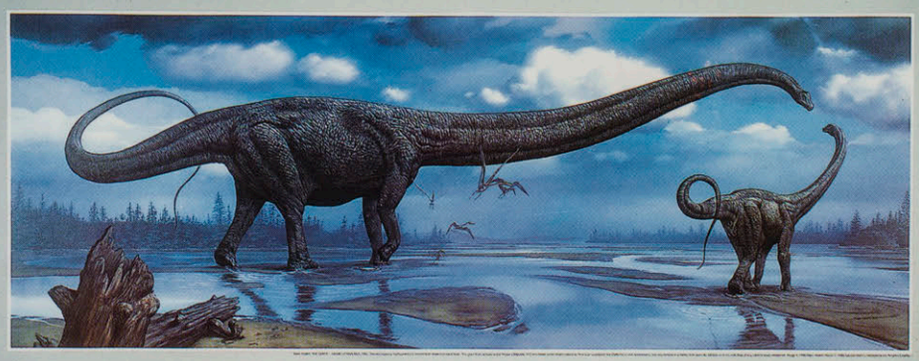
THE MIGHTY *MAMENCHISAURUS* ADORNS AWARD WINNING* MUSEUM POSTER

Renowned nature artist Mark Hallett lends a highly realistic and sensitive portrayal of a huge prehistoric creature known as *Mamenchisaurus*. Recently unearthed in the People's Republic of China, this animal boasted the longest neck — 33 feet — of any known vertebrate.

A cast of the fossil skeleton of this dinosaur belongs to the Natural History Museum, and the painting toured as part of the museum's Dinosaurs Past and Present exhibition. Now this distinctive rendering has been reproduced on an 18″ by 36″ poster and priced at $7.50. It is available at the Natural History Museum Bookstore or by mailing the handy mail order blank below.

*AMERICAN ASSOCIATION OF MUSEUM PUBLICATIONS COMPETITION AWARD OF MERIT



DINOSAURS PAST AND PRESENT

an exhibition organized by the Natural History Museum of Los Angeles County

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